Tucson Village Farm

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School Gardens and Beyond

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ARIZONA 4-H

THE UNIVERSITY OF ARIZONA. Cooperative Extension

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Dirt is Dirt, Soil has Character

The Living Soil

Topic-living organisms in the soil
Imagining an unknown world
Standards-

SC[00-HS]-S1,S3,S4

Materials

- Pencil and paper for each student
- Imagination
- Multimedia, Internet with projector

Intro
Scientists have learned a lot about soil and the tiny life forms that live in it. But there is still a huge amount that they do not know. A lot of what we do not know is how tiny life forms work with plants and who eats who in the soil.

Activity
For a moment, think about food chains above the soil. It all starts with the sun, plants use energy from the sun, a small insect will eat part of the plant, a ladybug will then eat the smaller insect, a larger insect will eat the ladybug, then a mouse will eat the larger insect and finally a snake will eat the mouse. We can see this chain of events and a chain of events like this is constantly happening under the soil.

- Imagine the world under our feet filled with bacteria too small to see without a microscope. Imagine that some bacteria eat dead plants in the soil while other bacteria live in the roots of plants.
- Imagine that there are bacteria that eat other bacteria.
- Then imagine that these bacteria were eaten by other bacteria.

All of this is too small to see without a microscope, but we can imagine what is happening. Nobody actually knows how this works so you can't be wrong.

On a sheet of paper, draw what your imagination sees. Imagine the biggest bacterium and draw it. Is this the king of the soil or do other bacteria eat it? Do these bacteria have legs, fins, fur or wings? They can have anything you want. Any bacteria can eat any bacteria because we do not know how it actually works.

Ask for volunteers to tell their story. Hold a pinch of soil and have them tell the class what is happening in the soil. This pinch of soil has as many living organisms as there are people in Tucson.

Further multimedia exploration

- Take a virtual tour of some organisms under our soil- http://archive.fieldmuseum.org/undergroundadventure/flash/VirtualTour.swf
- Explore a world of life on top of the soil not commonly seen http://www.youtube.com/watch?v=cqaR8xkJ8es
- USDA soil info packet for kids ftp://ftp-fc.sc.egov.usda.gov/MT/www/about/SoilAlive508.pdf

Conclusion
Without soil and the life it contains, our world would be nothing like it is today. In fact humans would probably not even exist. The living organisms below ground outnumber the living

organisms above ground. People are just beginning to understand this, the future holds tremendous opportunities to investigate and discover the world below our feet.

Roots in the Soil

Topic-Major plant nutrients and how to test for them

Standards-

SC[00-HS]-S1,S3,S4

Materials needed

- Soil test kit from http://www.arbico-organics.com/category/soil-test-kits ($15)
- Directions from the soil test kit. Following the instructions from the kit, prepare samples/sample **24 hours in advance** using a clear glass container for each soil sample.

Part 1-Intro

Review what a plant is, its major parts and major needs.

- A plant is a living organism such as a tree, bush, grass or cactus.
- Usually the major parts are leaves, stems, flowers and roots. Each part of the plant performs an essential function of survival. The stems hold the leaves. The leaves absorb energy from the sun through photosynthesis. The flowers are one of the main ways a plant is able to reproduce and transfer its genetic information to the next generation. The roots (an essential link to the rest of the lesson) anchor the plant to the ground while absorbing water and nutrients.

Part 2-Plant nutrients

Did you hear me mention the word Nutrient? Where does a plant find its nutrients?

- The plant absorbs nutrients from the soil with its roots.

If the plant is not able to find nutrients in the soil, it will not grow well and will not produce much food.

Now that you know how and where a plant finds nutrients and why they are important. Can anybody name one of the 3 major nutrients a plant needs?

- Students do not usually know these answers. The next part of the lesson is designed to develop a working understanding with action and repetition.

The 3 major nutrients a plant needs are Nitrogen (N), Phosphorous (P) and Potash (K). Write the nutrients name on the board and define them.

- **(N) Nitrogen-helps the leaves and stems grow quickly and develop a healthy color.** If the plant seems to be growing too slowly, the soil may be lacking Nitrogen. Too much nitrogen can make the leaves spongy and the stems weak.
- **(P) Phosphorous-helps the flowers make healthy seed, giving the next generation a strong start.** Imagine that you grow tomatoes and one plant produces a superior fruit. With the correct amount of Phosphorous in the soil these seeds will have a higher chance of sprouting and longer shelf life (viability).Of note-hybrid plants will produce infertile seeds or an offspring fairly different from the parent.
- **(K) Potash-gives fruits and vegetables a good taste and flavor while helping the stems and roots to be strong.** Have you ever eaten a fruit or vegetable that has very little flavor; if the plants break easily in the wind or seem brittle, the soil may be lacking in Potash.

Part 3-Getting comfortable with new information

The Nutrient Game

Now that the students have been introduced to the major nutrients plants need. Have them play a simple outdoor/indoor game (10 min).

- The students will invent actions to demonstrate the nutrients' function and then perform the action when the nutrient name is called out, similar to Simon says.
  - Nitrogen promotes fast growth so the students could sprint from one place to another.
  - For Phosphorous the students could ball up into a seed and then sprout.
  - Potash could be demonstrated by striking a body builder's pose followed by saying yum, yum, yum.
- Repeat several times until the students develop a working understanding.
  - The command of "classroom ½ Nitrogen," will bring them back to the classroom for the rest of the lesson.

Part 3-Rubber meets the road

Soil Testing-It is very important to know where you are going with this demonstration before you start. Are you simply testing nutrient availability in a soil sample, or are you starting with a base soil and then testing the amendments, showing how the combination of ingredients produces the end result.

- On the chalk board draw a chart with N, P and K along the top horizontal axis. Use the left vertical axis for the location or type of sample/samples.
  - Several ways can be used to denote test results. We use a + +, +, x, - and - - series from high to low, but the results can be numbered or color coded.
- Using the soil and water samples prepared yesterday students will do an NPK (Nitrogen, Phosphorous, Potash) test on each. Follow the directions on the soil test kit.
  - Several ways can be used to denote test results. We use a + +, +, x, - and - - series from high to low, but the results can be numbered or color coded.

Discussion of results-

- Which nutrients did you find and which were lacking?
- How do you expect the plants to respond to the nutrient levels in the sample?

From the Ground Up: Little Gardeners

Title

From the Ground Up: Little Gardeners (Pre K-K)

Topic

Gardening with small children; sunflowers

Standards

SC00-S1,S4,S5,S6
M00-S1,S2,S3
HealthPre-K-2-S1,S5,S7

Materials

Materials: green and yellow felt, black sharpie, hot glue gun, magnifying glasses (optional, but kids love using magnifying glasses!), 30 wooden rulers, dried sunflower heads with seeds intact, tweezers (optional), bananas, raisins, sunflower butter, roasted sunflower seeds, plastic knives, several small bowls, paper food boats, aprons, small tables.

Outcomes/Objectives

-Students will be able to

- Count from 1-30.
- Develop focus and attention skills by searching the garden for specific items.
- Measure plants in the garden.
- Identify sunflowers and count their seeds.
- Develop motor skills by carefully de-seeding sunflower heads.
- Describe pollination of sunflowers.
- Identify several varieties of sunflowers.
- Learn the four basic elements a plant needs to grow.
- Plant a sunflower seed.
- Assemble a nutritious sunflower snack.

Intro

The possibilities for learning in the garden are endless, and children are natural-born explorers. Help them establish their roots early with hands-on outdoor discovery. Learn how the garden can provide the setting for lessons in measuring, counting, estimating, and developing coordination and motor skills with a few simple materials. This lesson focuses on sunflowers, which provide a dramatic learning tool owing to their towering height. Sunflowers are perfect for measuring activities, for learning about pollination, and for practicing counting and fine motor skills.

Activities

Numbered sunflower activity

Make some felt sunflowers, using the yellow felt as the flower and the green felt as the stem attached to the ruler, but try to leave the numbers visible. Number the flowers 1-30 using a black sharpie. Hide these sunflowers in the garden by sticking them in the ground where kids can reach them, but may have to look carefully behind large leaves or amongst bushes.
Tell students that we are going on a scavenger hunt and they need to put on their eagle eyes to help you search far and wide for all of the sunflowers. Hand out magnifying glasses.
After the sunflowers have been collected, have toddlers line them up end to end in number order as a counting exercise. Have them walk the length of the lined up sunflowers to count how many steps it takes.

Then use your sunflower rulers to measure different plants in the garden. Who can find and measure the tallest plant? The shortest one? If you have sunflowers growing, help your students measure to find the tallest one. They can grow over 11 ft tall in some cases. Once you find the tallest one, use the rulers lined up end-to-end on the ground to show its length. Have students walk this distance and count their steps.

<u>Counting Sunflowers</u>

There are many different varieties of sunflowers. Some examples are Van Goghs, Mammoths, Sunrise. All have different characteristics. Some present multiple flowers per stem (Van Goghs), while others only have one. The multitude of shapes, sizes, colors, textures, and aromas can provide a wonderful sensory exploration activity.

Have students look for sunflowers in the garden and count how many they can find, pointing out that some have only one flower per stem and others have several. Point out different varieties of sunflowers: Van Goghs, Mammoth, etc. Use this opportunity to have them feel and smell the sunflowers. Once you have explored the whole garden, write down how many sunflowers are growing.

<u>Harvesting Sunflower Seeds & Counting</u>

Show students a few of the sunflower seeds, noting the shape and color. Do not allow them to eat these seeds since they have been visited by many birds in the garden, but explain that sunflower seeds are snacks full of protein that people have harvested and eaten for hundreds of years.

This is a good time to explain pollination. Ask the students why these flowers are so big and bright. Explain that this is to attract bees, butterflies, and other pollinators to land on them and collect their nectar and pollen. When bees land, they collect pollen from the flower and carry this pollen to other plants they visit. Sunflower heads are composed of hundreds of tiny, individual flowers. For a seed to develop, it must be pollinated. Extract a few sunflower seeds and break open the shells to demonstrate this point. Some will be empty (un-pollinated) and others will have the seed within (pollinated).

Next have students pluck sunflower seeds to place on your numbered felt sunflower rulers, Have them place the corresponding number of seeds on each sunflower (1 seed on #1, 2 on #2). You can also have them estimate how many seeds are on each head and then count to see how close their guesses were. Have them measure a few seeds with the rulers. How does such a tiny seed become such a tall plant?

Collect these seeds for planting, but remember that the un-pollinated ones will not germinate. Plant many to ensure some grow.

<u>Planting Sunflowers</u>

First have children crouch down on the ground, pretending to be a tiny seed. Ask them what things a seed needs to grow. When they guess water, pantomime watering all of them and so on for sun, earth, and air (optional fifth element: LOVE!).

Have the children start to grow by slowly standing and stretching their arms out as they become full plants.

Extension: explain how sunflowers' leaves follow the sun. Have a sunflower parade as they follow the leader (acting like the sun) around the farm.

Then have the children plant their sunflower seeds. Demonstrate to the children how far to poke a hole in the ground by having them find their second knuckle on their pointer fingers. Show them the black irrigation tape and ask them to make their holes right next to the line of tape. Instruct them to drop one seed per hole and cover it up. They can even make a wish as they do and blow kisses to their seeds to give them love. Don't forget to give these new seeds a quick hand-water, even if they are hooked up to irrigation.

Sunflower Snack: Ants on a log

First peel and pre-cut bananas in into quarters lengthwise (older kids should be able to do this step). Then cut each of these quarters in half, bisecting them so you have several banana "logs". Have several bowls of your raisin and sunflower seed toppings.

Have children wash their hands, emphasizing that me must do this before handling food when we've been in the garden. Pass out aprons for each child.

Give each child one of these banana log boats with a dollop of sunflower butter in the corner. Show them how to spread the sunflower butter onto their logs using their plastic knives. Then pass around the bowls of toppings and show them how to add the "ants" to their logs. Bon appetite!

Conclusion

Sunflowers are like bright neon signs that attract bees to our gardens. They come in many varieties and can grow like towering giants. Review with students what they have learned. Have them count from 1-30. Discuss how remarkable it is that a tiny seed can grow into a huge plant with just four main elements. Ask them if they can recall what those four things are. Review what pollinators are and how this relates to producing seeds. Have children measure the progress of their sunflower seeds. They can keep a log of the plants' heights as they continue to grow.

Other Ideas

Eat a Rainbow

Introduction

Ask children if they have ever seen a rainbow. What colors does it have? What on earth does it mean to eat a rainbow?! Can you eat a rainbow in the sky? Of course not, but you can eat lots of different colors in order to be healthy and strong!

Rainbow Scavenger Hunt

Materials: red, orange, yellow, green, blue, purple felt, popsicle sticks, black sharpie, glue gun, magnifying glasses (optional)

Objective: to use observational skills to find hidden objects and to practice colors while identifying different kinds of fruits and vegetables

Preparation: using felt and sharpie, design 20 to 30 fruits and vegetables of different colors. Attach these to popsicle sticks using hot glue gun. Hide these in the garden at appropriate difficulty level for wee ones.

Have kiddos search for fruits and veggies. Once collected, go through the colors of the rainbow and identify what fruits and veggies they have found. Example: "ok, what color comes first in the rainbow? Red! Who has something red? What type of fruit of veggie is it?" Do this for all the objects found.

Color Walk in the Garden

Materials: magnifying glasses

Objective: identify actual fruits, vegetables, and flowers growing in the garden and practice colors.

Lead children through the garden and look for something of every color of the rainbow. Ask them to identify what type of plant they are looking at. Explain if they do not know.

Read Aloud

Materials: *Eat Lots of Colors* book

Objective: to talk about why we need to eat lots of colors of plants

Read story aloud to children.

Color Matching Game

Materials: red, orange, yellow, green, blue, purple felt squares, assortment of plastic fruits and veggies and felt fruits and veggies from scavenger hunt, basket.

Objective: to have children identify colors and sort them to corresponding squares, while learning about various fruits and vegetables and how they are good for us.

Lay out the squares in rainbow order and with plenty of space. Start out by pulling individual fruits and veggies out of basket. Ask children to identify what they are and what color they are. With each color, talk about why it is good for us: orange and yellow boost immunity, green is good for our bones because it has calcium, etc. Have children take turns placing fruits and veggies on the corresponding color square.

Eat a Rainbow Snack

Materials: mayonnaise, greek yogurt, olive oil, milk, garlic, various herbs from the garden, salt, pepper, lemon, mixing bowl, cutting board, knife (only for adult use), plastic spoons, paper food boats, tray of various colored veggies for dipping, aprons, gloves.

Objective: have children practice motor skills by mixing in their own herbs into their dressing and have them practice eating a rainbow by eating various colored fruits and veggies.

Have children go out to the herb garden and pass around various herbs for them to touch and smell. Have them help choose which herbs they would like in their dressing. Have the adult harvest a handful of herbs and wash them.

Have children wash their hands.

Pass out aprons, and have parents help their children put them on.

Demonstrate how to make a simple ranch dressing. Use equal amounts mayonnaise and greek yogurt, a small amount of milk and olive oil, the juice of half a lemon, and two finely chopped garlic cloves, and some salt and pepper to taste. Chop up herbs and place in a paper boat. Provide a dollop of dressing in each boat, along with a plastic spoon. Next, pass around the boat filled with chopped up herbs and have each child take a pinch. Have them stir in their herbs.

Pass around veggie tray for children to take various veggies for dipping into their dressing.

Wiggly Worms, Lovely Ladybugs and Buzzing Bees (and the ABCs)

Ladybug Scavenger Hunt

Materials: ladybug life cycle printed from internet, red felt, popsicle sticks, black sharpie, hot glue gun, magnifying glasses (optional)

Objective: to familiarize children with ladybugs as they search for felt ladybugs in the garden, and to practice ABCs.

Preparation: Make some felt ladybugs with the red felt and black sharpie. Instead of spots, use a different letter of the alphabet for each ladybug. Attach these to popsicle sticks using your glue gun.

First show the children the life cycle of the ladybug to familiarize them with what they look like. Ask the children why we want ladybugs in our garden. Explain to them that ladybugs eat a lot of insects that are harmful to our plants.

Pass out magnifying glasses, and tell the children to put on their eagle eyes to look for felt ladybugs.

Once they have been found, sing the alphabet and have the children line up the ladybugs in alpha order. Then ask them to spell different words with them (garden-themed, especially!).

<u>Live Insect Scavenger Hunt</u>

Materials: magnifying glasses

Objective: to have children identify and observe various insects inhabiting the garden

Have children look in the garden for real ladybugs, bees, butterflies, grasshoppers, ants. Ask each child one insect that they found in the garden during their hunt.

<u>Digging for Worms</u>

Materials: worm bin, the book *Diary of a Worm*

Objective: to introduce children to worms and how they benefit our garden through hands-on exploration of a working worm bin.

First read *Diary of a Worm* to toddlers. Then reach into worm bin and pull out a worm to pass around. Ask children why we have worms. Explain that just like in the story, worms eat our food waste and some of our trash. Explain that worm poop is a fertilizer, called "castings" for our plants. Pass around a jar of castings for toddlers to feel and smell.

Next have children gather around the worm bin and dig for their own worms. Explain to them that they need to keep the worms over the worm bin because worms do not like sunny, hard, dry dirt. Worms like to be cool, in the dark, and moist.

<u>Worm Snack</u>

Materials: sunflower butter, powdered milk, honey, paper food boats.

Objective: to have toddlers shape their snack into worm and letter shapes and taste some honey to introduce bees. Note: this snack is safe for a child 2 and up. It is not recommended to feed honey to a child younger than 2 years old.

Preparation: Mix two cups of dry powdered milk, two cups of sunflower butter, and one-half cup of honey in a mixing bowl to make pliable dough.

Hand out balls of dough to toddlers and show them how to roll it out to make a worm shape. Also show them how to make some simple letter shapes.

Then eat up!

<u>Bee Pollination</u>

Materials: dark colored pipe cleaners, twisted into looped "bee" shapes, double-stick tape.

Objective: to teach children about pollination as they "pollinate flowers" in the garden.

Preparation: loop pipe cleaners into a rough bee shape. Apply double-stick tape so that pollen will collect.

Briefly explain that bees make honey by drinking nectar from flowers. As they do this, they also collect pollen. When they visit many flowers, the pollen mixes together and lets some of those flowers produce fruits and some of our veggies.

Pass out pipe cleaners to children and have them find flowers in the garden. Show them how to "pollinate" by rubbing their bee gently in the center of the flower. Have them visit many flowers in the garden. At the end, they can look at all of the pollen they have collected.

Even More Ideas!

Pumpkin theme

Have students dissect pumpkins (with some grown-up assistance with the knife). Explain the different parts of the pumpkin and have students describe the textures, smells, and appearance of each part. Have them extract the seeds to roast later!

Use pumpkin seeds to make art. Have students glue down seeds to simple picture outlines or make their own line drawings to cover with seeds.

Use pumpkin seeds as materials for learning about volumes. Have kiddos fill various-sized containers with pumpkin seeds.

Seed science theme:

Teach children about different types of seeds by dissecting various fruits and extracting the seeds with tweezers.

Make flashcards of various fruits and veggies and have students try to match seeds to what they think they will grow into.

Dissect a seed! Soak some lima beans overnight. Have students pull them apart and identify the different parts of the seed.

Make popcorn! This is a great way to learn about seeds AND whole grains! Teach the three parts of a whole grain and ask students if they think popcorn is a whole grain and why. It is—it's just inside out.

Resources

Books for read-aloud:

Anholt, Laurence. 1994. *Camille and the sunflowers: a story about Vincent Van Gogh*. Hauppauge, NY: Barron's.

Cronin, Doreen, and Harry Bliss. 2003. *Diary of a worm*. New York: Joanna Cotler Books.

Krauss, Ruth, and Crockett Johnson. 1945. *The carrot seed*. New York: Harper & brothers.

Sayre, April Pulley. 2011. *Rah, rah, radishes!: a vegetable chant*. New York: Beach Lane Books.

Stevens, Janet, Ray Tomasso, Warren Wallerstein, and Ginger Boyer. 1995. *Tops & bottoms*. San Diego: Harcourt Brace & Company.

Gardening with toddlers:

http://www.naeyc.org/files/yc/file/200801/BTJNatureNimmo.pdf

Other kindergarten lesson plans:

http://collaboratingclassrooms.ath.cx/?garden=/nutrition&section=curriculum

Gardening on the Cheap

Title: Gardening on the Cheap
Topic: Building and Using a Salad Box™ or Salad Table™
Standards:

SC[00-08]- S1,S2,S4	M[00-06]- S1-S5	ET[00-06] S2,S6
SCHS- S1,S3,S4	M[07-MCWR]- S1,S2,S4	ET[07-HS] S1-S3,S5,S6

Objectives:

Students will be able to…

- Calculate materials needs and cost
- Measure and cut materials to desired lengths
- Construct a Salad Box™ or Salad Table™
- Create an effective soil mix and describe the benefits of each "ingredient"
- Grow and maintain their own lettuce, greens, and other veggies and herbs
- Calculate, record, and compare production, graphing results
- Calculate production costs

Materials:

Salad Table™

Untreated, framing lumber:
- ◦ Two 2 X 4s, 10' long
- ◦ Two 2 X 4s, 12' long
- 3" galvanized wood screws
- 3/8" staples
- Roofing nails
- 3' X 5' roll of 1/2" mesh hardware cloth (This is a galvanized wire mesh that comes in a roll.)
- 3' X 5' roll of aluminum window screening
- Handsaw
- Hammer
- Drill
- #2 Phillips screw bits
- Tape measure
- Square
- Tin Snips
- Staple gun
- Leather gloves

Salad Box™
- One 6' cedar or pine (1x4)
- Eight 1 5/8" galvanized screws
- Aluminum window screening
- ¼" hardware cloth
- Handles w/ screws (optional)
- Staple gun + staples
- Handsaw
- Drill
- #2 Phillips screw bits
- tape measure
- square
- tin snips
- leather gloves

Intro: Close your eyes and picture a garden. Now, who envisioned their garden in a beautiful, rural area, with rows of plants sprouting from the ground? Did anyone imagine their garden in a bunch of boxes and tables? Well, the University of Maryland's Maryland Cooperative Extension did. They saw 58x33 inch tables and a 23x15 inch boxes. Sounds strange, sure. But both are easy to construct, cost-efficient and portable; and that makes them perfect for urban homes, schools and after-school programs.

Activity 1: Build your Salad Box™ or Salad Table™ (See MCE handout)

- Gather a materials list
  - Calculate cost of materials
  - Borrow vs Buy tools

Activity 2: Create a "Farm Journal" (See Handout)

- A farm journal offers you the ability to reference previous growing seasons, helping you identify which crops thrive as well as which do poorly, and identify patterns. Over the years, you'll have created your own personal "Farmers Almanac"
- Although a typed up and printed journal has its benefits, I suggest allowing students to make their own hand-made journals—with sketches and artwork related the their findings—that they can then keep. Of course, you'll need them to type up a final copy for your records (for later reference), and you may even want to take a photo or two of the greats.

Activity 3: Getting Started

- Choosing a location
  - Level surface
  - Crop appropriate sunlight (refer to local Extension office)
- Soil composition
  - The best growing medium is 50 percent soilless mix and 50 percent high-quality compost. The commercial soilless mix usually contains peat, perlite, and vermiculite, but new organic soilless mixes contain coir (shredded coconut fibers) and rice hulls. Work water into the soilless mixes to get them moistened. Then, combine the soilless mix evenly with the compost and fill the frame to the top -- it will settle some, and that's fine.
  - Farmer Grover's Formula: 50% finished compost, 25% peat moss, 12.5% vermiculite, 12.5% perlite
    - An experiment: if you have multiple boxes/tables, vary the proportions and track results (be sure to make note of soil composition for each!).
- Planting, watering, and thinning*:
  Videos at: http://growit.umd.edu/saladtablesandsaladboxes/index.cfm
  - Planting methods
  - How to…
  - Why?
  - What to do with the pulled plants?
  - *Note that these videos are based on Maryland climate/planting seasons. Planting seasons and watering needs will vary depending on

your location. Refer to your county's UofA Extension office for tips and advice.

Activity 4: Harvest and Record

- Record general germination (days after planting)
- Measure and record height weekly
- Record how much/when fertilizer added (and what type)
- For harvesting tips, refer to videos at above site
- Weigh and record harvest (days after planting and weight)
- Measure cost of seeds, water, and other costs, and compare to store-bought items or even the farmer's market value of the produce (let them calculate how much money they could make if they were selling their produce after cost/overhead). As the seasons progress, compiling findings can be a great way of choosing the most productive or cost-efficient crops, as it provides a wealth of knowledge to those who are lucky enough to reference it!

Conclusion: It may just look like a box or table, but the reality is, it's a year-long scientific method in action, year after year. It's a science and nutrition lesson, an engineering lesson, and a math lesson. It's all that and more; simple, cheap, and wicked fun.

Follow-Up: At the end of a growing season, it's a great idea to graph results. It makes for a quick-glance summary of the season.

Sources:

- University of Maryland – Maryland Cooperative Extension
  - http://growit.umd.edu/saladtablesandsaladboxes/index.cfm
    - Directions on web (or downloadable PDF) for building, prepping, and utilizing Salad Table and/or Salad Box

Getting to Know Your Garden

Title Getting to Know Your Garden - One Leaf at a Time

Topic

Students will grow their own vegetable from seed to table. Students will keep their own plant journal to draw their plant daily, list plant parts, list the daily care needed for their plant, and note any observations made in the change/growth of their plant. Students will come up with their own solutions for plant problems by collaborating with their fellow classmates—as well as with students of other schools when possible—and comparing plant care notes and observations.

Standards

SC[00-08]-S1,S2,S3,S4,S5,S6
ET[00-08]-S1,S2,S4,S5

Materials

Cups with holes punched in the bottom and soil mix (or plant directly in your school garden). Seeds, measuring spoons/cups, measuring stick, and plant journal.

Objectives/ Outcomes
Students will be able to:

-understand the time and patience necessary to growing vegetables and learn how to be an observant farmer.

-carefully track and log the condition of their plant from the time from which it was planted to harvested.

-log the weather, watering schedule, growth of the plant, pests seen, condition of their plant weekly, and learn how these elements effect the success and growth of their vegetable.

-identify parts of the plant and the plant's life cycle.

-collaborate with peers and communicate with students from other schools in Arizona to discover solutions to problems that arise and make comparisons regarding their mystery plants

Intro

A group of scientists thinks they may have discovered a new variety of vegetable! They asked the worlds greatest farmers to grow the vegetable from seed and carefully log and measure how the plant grows and forms in each stage of its life. It is each of your job to grow this mystery vegetable and determine how it grows best - how much water, how much sunlight, and how much care it needs to grow. Here is your Plant Log where you will meticulously draw and log the plant as it grows and record how it tastes when it's ready to eat. So don't make a mistake, you will be eating your vegetable later on your dinner plate! Feel free to talk to your fellow farmers and talk to each other on how your plant grows, but don't ask your teacher, she does not know.

Activities

-Update your plant log every day for 3 weeks.

-When your plant begins to grow, research and construct a hypothesis weekly on what type of vegetable you think is growing, or what family it might belong to.

-Design a chart or graph to track the progress of your plant. Compare differences in time/growth, water/growth, sunlight/growth.

-Compare your chart with the chart of others in your class. Is your plant doing better or worse than the other student's plants?

-Brainstorm solutions on how to improve the health of your plant. Note any changes in your plant journal.

Conclusion

Students will understand the complete life cycle of a plant, the parts of a plant, and the variables that affect a plants growth.

Homework

Research and construct a hypothesis on what type of vegetable is growing, or what family it might belong to.

Resources:

Botany Flip Chart available at www.ibotz.com/biology/plant-biology/botany-flip-chart.html

The Encyclopedia of Natural Insect & Disease Control, edited by Roger B. Yepsen, Jr.

Rodale's All-New Encyclopedia of Organic Gardening

Keep Your Garden Green

Title
Keep Your Garden "Green" (1^{st}-5^{th} grade)
Topic
Eco-friendly art projects for the garden; reducing your carbon footprint
Standards
SC[00-05]-S3,S4,S6
Materials
Recycled seed packets decorated with plant dyes: Newspaper or other scrap paper, seed packet template, pencils, scissors, tape or glue sticks, paint brushes, pint jars, sharpies, various plants to make dyes, knife, strainer
Outcomes/Objectives
-Students will be able to

- Understand and discuss how wasteful consumption contributes to the creation of toxic environmental conditions.
- Understand that plants contain natural chemicals that produce pigments.
- Explain three reasons why plants contain colors.
- Identify which plants are best suited for dyeing through experimentation.
- Hypothesize why some plants are better suited for fabric dyeing.
- Identify historical uses for plants.
- Assemble a seed packet from recycled paper.

Intro
The garden provides the perfect canvas for creative inspiration and artistic exploration. It also provides a backdrop for discussing our impact on the environment. With the concept of reduce, reuse, recycle in mind, learn how to use plants from the garden to make "green" creations, such as natural plant dyes to decorate handmade seed packets.
Activities
Recycled seed packets decorated with plant dyes
Have each child trace the seed packet template onto some recycled paper. Cut out the patterns and fold as shown in the diagram. Glue or tape the side and bottom flaps, leaving the top open. To close the seed packet, tuck the top flap into the body of the packet.
Have students discuss some reasons they think plants have different colors. Explain that plants contain chemicals that produce different pigments. The green in leaves comes from chlorophyll which helps plants convert sun energy to chemical energy, which the plant stores and uses for food. The colors displayed by flowers are generally to attract pollinators, and the colors of fruits tend to attract animals which will eat them and spread their seeds.
To decorate the seed packets, use a method for creating plant dyes that the Native Americans used*, and use the power of the sun. Through this activity, kids will experiment with plants to find which ones create colorful dyes and what colors plants produce. The results might be surprising! For a list of recommended plants, see below. Have the kids gather plant materials that they think might work to create dyes. Chop up these plants and place in pint jars, filling each one nearly to the top with water. Cap the jars (you may have to use plastic wrap over the mouth of the jar if the lid contains metal. The metal may react with the dye). Label the jars with the contents so the results can be recorded later. Have students write down predictions for the colors the plants will produce. Leave these jars in the sun for several days, and then open them and strain out the solid plant matter into the compost pile. Have the children decorate their seed packets with their plant dyes and record the results of their experiment. Which plants

produced which colors? Were any of them surprising? You can even experiment by adding alum to the dye as a mordant (an agent that sets a dye) and see if the colors appear more vibrant.
*This activity adapted from kidsgardening.org

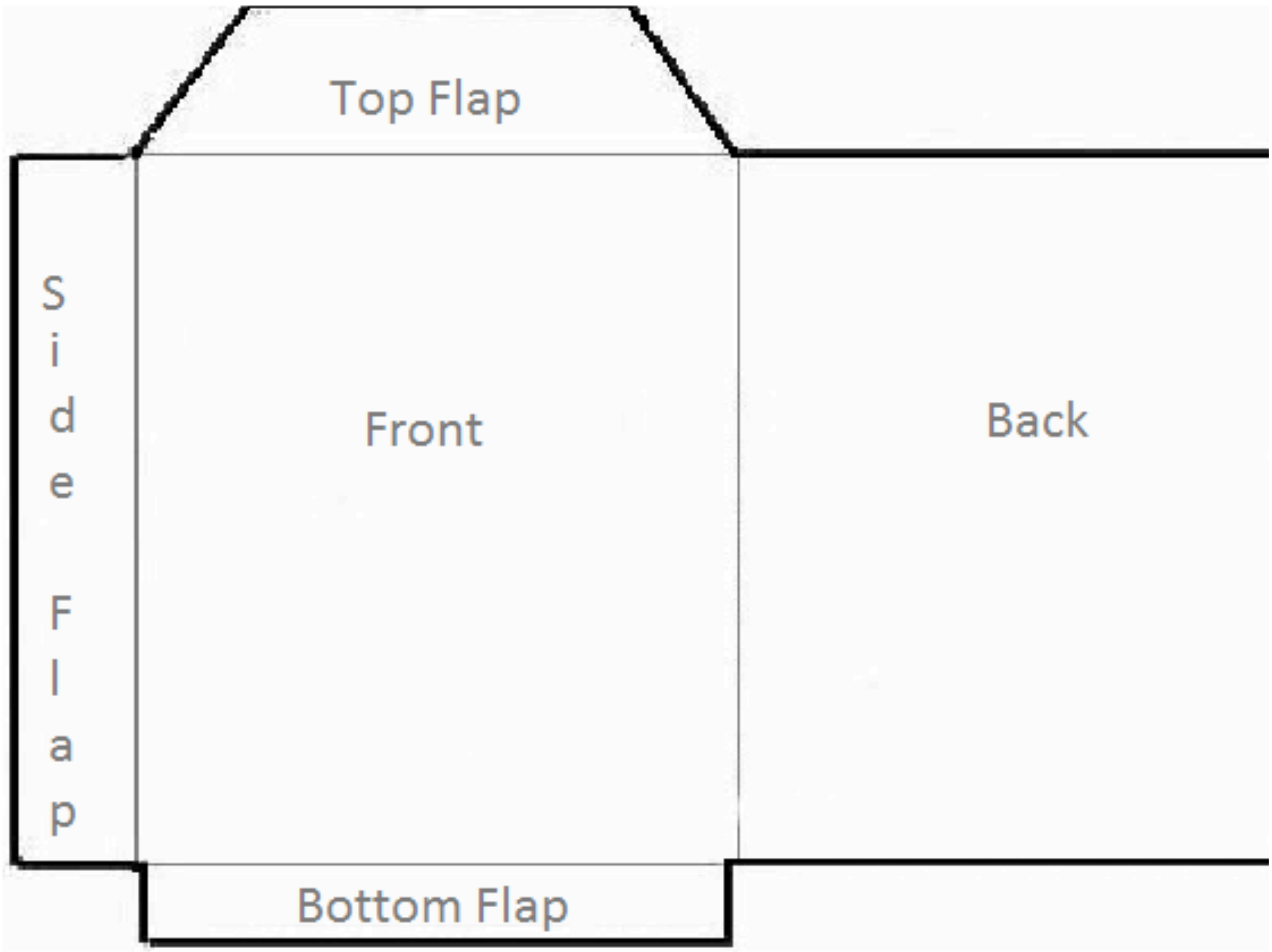
Conclusion

Humans produce many toxic substances and huge volumes of waste that end up in landfills. We can reduce our negative impact on the environment by using reusing materials and finding non-toxic alternatives to artificial chemicals. We can use many plants from our own gardens, which display a rainbow of colors and produce an array of pigments as non-toxic, natural alternatives to artificial dyes, just as people have for thousands of years. Different plants will produce different colors, sometimes unexpectedly. Some plants may not produce viable pigments because their chemical compounds do not bind to the fibers of the paper, and some may bind better with additives such as vinegar, salt, sugar, etc.

Homework/Follow-Up

Expand on this project by experimenting with various fabrics and by adding other ingredients to your dyes, such as vinegar, salt, sugar, etc. (a whole chemistry lesson within itself!).
To add another dimension to this activity, discuss the prehistoric and historic uses of natural plant pigments (ex: cave paintings).

Seed Packet Template



Recommended Plants for Natural Dyes
red cabbage, tomato leaves & stems, mint, parsley, calendula, chamomile, dandelion, marigold, zinnias, mild mustard, spinach, carrot leaves, kale, turmeric, sunflower seeds, sunflowers, coffee grounds, red cabbage, wild grapes, mulberries, onion skins

Other eco-art ideas:
Recycled wind chimes: various found objects (esp. metal, like utensils, bike parts, screws, nuts, bolts, old keys etc.); old bike tubes; scissors; fishing line; small twig, plastic lid, or anything that can be used as a central piece from which to hang the chimes
Seed balls: seeds, mud
Seed paper

Resources:
List of recyclables in Tucson:
http://cms3.tucsonaz.gov/sites/default/files/esd/lwn_flyer_eng-span_web.pdf
What's Up with Trash? All about landfills and the three R's for kids:
http://library.thinkquest.org/06aug/00442/wu3rs.htm
Making natural fabric dyes:
http://www.kidsgardening.org/classroom-projects/dyeing-find-out
Other wildlife eco-crafts:
Texas Agricultural Extension Service, National Wildlife Federation 2004. *Junior Master Gardener: Wildlife Gardener*. JMG Kids: College Station, TX.
Making seed paper greeting cards:
http://www.nwf.org/news-and-magazines/national-wildlife/outdoors/archives/2011/homemade-paper.aspx
Making newspaper planters for starts:
http://www.forgreenies.com/origami-newspaper-seedling-pots
http://www.wikihow.com/Make-Newspaper-Seedling-Pots

Pizza by El Sol

Title:
Got sun?

Topic:
Wait! Don't throw out your last night pizza box. Save it to help create your next meal. Learn about the wonders of the sun and how to harvest its power by learning the three basic principles of passive solar design and implement your sun knowledge to construct a solar oven pizza box and cook up some healthy snacks.

Standards:
SC[06-08]-S1,S3,S5
SCHS-S1,S3
M[06-HS]-S4,S5

Materials:
- A recycled large pizza box
- Black construction paper
- Aluminum foil
- Clear plastic wrap
- Scissors
- Box cutter
- Glue
- Tape
- Ruler
- Black pen or marker
- Push pin and pencil or stick to act as dowel
- Flashlight or laser pointer (optional)
- Small thermometer

Objective/Outcomes:
Students will be able to:
- Demonstrate their knowledge of passive solar design by incorporating two of the three principals for construction
- Construct a pizza box solar oven
- Measure temperature and cooking time
- Observe and measure angle of sun for optimal heat gain
- Experiment with different recipes and record results

Intro:

The sun is a wonderful energy, which all life on earth revolves around. Without the sun all life on earth would cease to exist. The sun is actually an average star. There are other stars that are much hotter or much cooler, some stars that are much brighter or fainter, or some that are much larger or smaller. For example, a star found in the galaxy (Large

Magellanic Cloud) next to ours holds a star that is 320 times the size of our Sun and around 10 million times brighter! However, since the Sun is the closet to the Earth it looks much bigger and brighter than any other star in the sky and the only star we can see during the day.

The sun is mostly made up of the elements hydrogen and helium, and is neither a solid nor a gas, but is actually a plasma. Plasmas are complicated to understand, but at the surface of the sun the plasma is gaseous and as you travel deeper into the Suns center plasma gets denser. The center, referred to as the core, produces the energy to power the Sun as well as all the heat and light that we receive her on Earth. All of the energy that we detect as light and heat on Earth originates from the nuclear reactions deep inside the Sun's high-temperature core, which extends about one quarter of the way from the center of the Sun where temperatures are around 15.7 million Kelvin (K) or about 28 million degrees Fahrenheit.

Unlike many of the fossil fuels humans depend upon, solar energy is a clean and renewable resource. Although Earth only receives one ten-billionth of the total output of power from the sun ($4X10^{26}$ watts), more energy strikes Earth in a few hours than is consumed by humans in an entire year.

We can use the energy we receive from the Sun as a practical source of energy for heating our homes, our water, and even cooking. This is called passive solar design and the challenge is to find ways to capture and concentrate the energy so it can be used as efficiently as possible. Passive solar design refers to building design that maximizes the collection, storage, and distribution of solar energy by not involving the use of mechanical and electrical devices. There are three basic principles of passive solar design and they work in concert with each other to accomplish a goal, in our case to cook food in a solar oven. The first principle is Solar Gain, which is the arranging for sunlight to enter a device as a source of energy. In this activity, solar gain is accomplished by reflection of the panel by use of aluminum foil and accomplishing direct gain and enhanced by using dark colored surfaces to absorb the solar energy that enters the device. Have you ever sat in the sun wearing a pair of dark jeans or a dark tee-shirt and felt incredibly hot? The most efficient way to use the heat from sunlight is shine lots of sunlight onto a dark surface because dark surfaces absorb most of the Sun's visible light that falls upon them and reflects very little. An object absorbs all colors of solar light except for the color pigment it contains. This color is instead reflected off the object and back to the human eye; i.e. we perceive a red apple as red because only red light is reflected off of it, while absorbing all other colors of the spectrum. For this reason, we can understand why white objects are best for reflection of light and why black objects are best for absorption of light. This is because white is a mixture of all colors and thus all light is reflected off of it, while black is the absence of all color and therefore absorbs all light.

The second principle is Insulation, which is containing heat by trapping air inside and around a device to contain heat, and reflecting thermal radiation back into a device. In this activity the cardboard pizza box walls and plastic wrap accomplish insulation by helping to keep heat inside the pizza box. The third principle is Thermal mass, which is any material that absorbs and releases heat regulating to an even temperature. Large amounts of food will provide some thermal mass causing the oven to heat up more slowly. A baking stone is another example of how to use thermal mass while cooking, which we will not be requiring for this activity. In the future, pizza box solar oven improvements might incorporate some material that could regulate thermal mass.

Angle of incidence, also called Angle of Insolation is the angle at which solar radiation strikes the Earth's surface. Different angles of incidence correspond directly to different intensities of solar radiation received by Earth's surface, altering the surface's capacity to either absorb or reflect energy waves. Simply put, the position of the sun in the sky affects how much solar radiation we receive and what happens to that radiation when we receive it. Insolation is greatest when the sun is overhead as the radiation beams down directly and concentrates the light to the smallest possible area. As the angle decreases, intensity of insolation decreases because the sun's rays become farther and farther spread out over Earth's surface (See figure 1 & 2). As a result, time of day is a very important factor with regards to intensity of insolation. At solar noon, 12 o'clock PM, one can experience the part of the day with the most direct sunlight. Angle of incidence is greatly affected by the seasonal patterns of the Sun. Ever wonder why it's hotter in the summer and colder in the winter? Our planet orbits around the Sun all year in an ellipse while tilted on an axis of 23. 5 degrees. This combination creates a cycle of colder and warmer temperatures worldwide. We, living in the northern mid-latitudes, undergo summer weather when the northern hemisphere is tilted towards the Sun, increasing angle of incidence, intensifying solar insolation, and increasing temperature. June 21st is a day we refer to as the Summer Solstice because the Northern Hemisphere is tilted towards the Sun at a maximum, creating the greatest angle of incidence we experience all year. Conversely, we undergo winter weather when the Northern Hemisphere is tilted away from the Sun, decreasing angle of incidence, weakening solar insolation, and decreasing temperatures. December 21st is deemed the Winter solstice as the Northern Hemisphere is tilted away from the Sun at a maximum, creating the smallest angle of incidence we experience all year. Our fall and spring seasons are determined by the time of year when the tilt of the Earth's axis is inclined neither away from nor towards the Sun. We call this occurrence an equinox and we undergo one on or around September 23rd, Autumnal Equinox, and one on or around March 21st, Vernal Equinox. In this way, we generally experience mild temperatures in the fall and spring, as the solar insolation we receive is neither very strong nor weak.

Activity:

The pizza box we plan to build is capable of reaching temperatures of 275 degrees, hot enough to cook some food.

Step 1: Draw a square
Using the ruler and black marker, draw a square on your pizza box lid, leaving a 1-inch border from the edge of the box to each side of the square.

Step 2: Form the Flap
With the box cutter (under supervision) cut through three sides of the square you just drew, leaving the line at the rear of the box attached. Fold the Flap back so that it stands up when the pizza box lid is closed.

Step 3: Cover the flap with foil
Cover the underside of the flap with heavy-duty aluminum foil, which will reflect sunlight into the oven. Glue the foil to the flap, smooth out wrinkles and cut off any excess.

Step 4: Tape Plastic Sheet
With scissors, cut two square pieces of clear plastic wrap, each 1 square inch larger than the flap opening. Open the pizza box, and tape one piece of plastic to the underside of the hole so that the plastic covers it.

Step 5: Tape second plastic sheet
Close the lid, and tape the second plastic sheet over the top of the hole, creating a window that helps keep the suns heat in the box. Pull both sheets taut as you tape them.

**Maintaining an airtight box is crucial in keeping the oven hot

Step 6: Layer the bottom with foil
Glue or tape a layer of aluminum foil to the inside bottom of your pizza box for insulation.

Step 7: Cover with Black paper
Cover the foil layer in the box with sheets of black construction paper and glue them into place. The black base will absorb light and generate more heat inside our ovens.

Step 8: Find Best Angle
Close the lid, and you're ready to start cooking! On a bright day, place your solar oven outside in direct sunlight. Adjust the foil flap to find the best ray-reflecting angle. Use your dowel to hold the flap up and a push in your pushpin to hold your dowel in place.

**If you want to test the reflector angles of your oven before you head outside, shine a laser pointer (or flashlight) onto the foil flap to simulate rays of sunlight.

Step 9: Preheat
Preheat your oven by leaving it in direct sunlight for 30 minutes for optimal cooking experience.

Step 10: Cook
Whatever you decide to cook, place it (on its own, or in a heat-safe container) in the center of the oven so that it is directly under the plastic-wrap window. Close the lid, leaving the flap propped open and check often.

These ovens will reach 275° in 25 minutes on a day when the Angle of insolation is over 60° and can reach 200° even when the angle is around 48° (at the equinoxes). As late as mid November around noon or as early in a calendar year as early March, at noon these ovens can reach 150°-175°.

Optional Features:

- Add additional flaps to reflect sunlight into the oven. This can substantially increase the gain of the oven. This will require some extra cardboard (some old boxes for example).
- Crumple up some sheets of newspaper and stuff them around the inside of the box, to provide extra insulation.
- Placing a thermometer inside the oven as well to measure temperature.

Besides explaining the principles in the process of building and using the ovens, here are several other points you might want to make:

- Cooking food takes a lot of energy. By using solar energy, we can save a lot on fuel.
- Cooking takes time, and the Sun will change position during that time. Therefore, somebody, such as a vigilant cook, may need to align the solar oven now and then to keep the sunlight entering. Mechanisms that track the sun and adjust the device automatically are called "heliostats" (like thermostat, but with "helio", which means "Sun" instead).

- Solar ovens have been used for a long time. In the 1830s, the British astronomer John Herschel used a solar collector box to cook food during an expedition to Africa. Nowadays, one can buy commercial solar ovens, ranging from small single dish units, to large units that can feed many people at once and that have to be hauled around on a trailer.
- Without the reflector flap, the solar oven becomes what is called a "flat plate collector". Flat plate collectors are used for many applications, such as heating water (the reason for not using a reflector is that it is not really needed for these applications and thus alignment difficulties associated with reflectors can be avoided). One of the first known uses of solar hot boxes was by the cooks of the Roman Emperor Tiberius who wanted to eat cucumbers all year round. The cooks satisfied his regal appetite by using a solar hot box, a kind of flat plate collector, to grow the cucumbers all winter long. Nowadays, many people also use flat plate collectors to heat water for their pools and houses.

Temperature Data

Keep track of your temperature data here, and plot the results of both trials on the graph provided. Use a different-colored pen or pencil for each trail.

Recipe 1:
Date:
Outside Temp:

Starting Temp: ___________
At 5 minutes: ___________
10 minutes: ___________
15 minutes: ___________
20 minutes: ___________
25 minutes: ___________
30 minutes: ___________
35 minutes: ___________
40 minutes: ___________
45 minutes: ___________
50 minutes: ___________

Recipe 2:
Date:
Outside Temp:

Starting Temp: ___________
At 5 minutes: ___________
10 minutes: ___________
15 minutes: ___________
20 minutes: ___________
25 minutes: ___________
30 minutes: ___________
35 minutes: ___________
40 minutes: ___________
45 minutes: ___________
50 minutes: ___________

Recipe 3:
Date:
Outside Temp:

Starting Temp: ___________
At 5 minutes: ___________
10 minutes: ___________
15 minutes: ___________
20 minutes: ___________
25 minutes: ___________
30 minutes: ___________
35 minutes: ___________
40 minutes: ___________
45 minutes: ___________
50 minutes: ___________

Recipe 4:
Date:
Outside Temp:

Starting Temp: ___________
At 5 minutes: ___________
10 minutes: ___________
15 minutes: ___________
20 minutes: ___________
25 minutes: ___________
30 minutes: ___________
35 minutes: ___________
40 minutes: ___________
45 minutes: ___________
50 minutes: ___________

Please plot your results on a graph you can make on line paper.

Follow up questions:
Based on the recipes tested, what were the differences between the cooking times.
Which worked better than the others? Why?
Can you come up with some easy foods to cook in your solar oven?
Please plot your results on a graph you can make on line paper.

Follow up questions:
Based on the recipes tested, what were the differences between the cooking times.
Which worked better than the others? Why?
Can you come up with some easy foods to cook in your solar oven?

Discuss and compare the use of the sun as an energy source to one or all of the following types of energy sources: wood, fossil fuels such as coal or oil, nuclear power, wind, or water.
What are some ways the sun can be collected and used as an energy source?
Which location on Earth would be the best for using solar ovens and why? Which location on Earth would not work so well with solar ovens?
Choosing a variable on the pizza box solar oven design to improve. Redesign the model for improvement and list reasons for change.
If possible, create your new and improved solar oven design.
If you have recreated your solar oven, conduct another round of testing. Plot the results on your original graph using a different color.
Discuss the strengths and weaknesses of the final solar oven design.
How did it the first data compare with the second?
What design factors seemed to be the most important?
Was the most efficient cooker (the one that heated food faster) also the least expensive in terms of material cost? The most portable?

Conclusion:
The Sun has so much energy and life to provide to us. Nowadays there is a wider focus on how to harvest the Suns energy to have a cleaner energy source. Students learn about the Sun while realizing how much energy potential it has to provide to humans. With the use of recycled and low cost items, students learn to create their own solar oven so they too can harvest the Sun's energy while testing different healthy snacks recipes to cook up for themselves and others.

Adapted From:

- Daniel Merin and Mike Zamm, 2006. *Solar Ovens and Earth Science*, GrowNYC www.grownyc.org
- New Mexico Solar Energy Association, *Make a Pizza Box Solar Oven.* www.nmsea.org
- Nova, *Saved by the Sun*

http://www.pbs.org/wgbh/nova/education/activities/3406_solar.html

Figure 1.
The spin axis of our planet around the sun

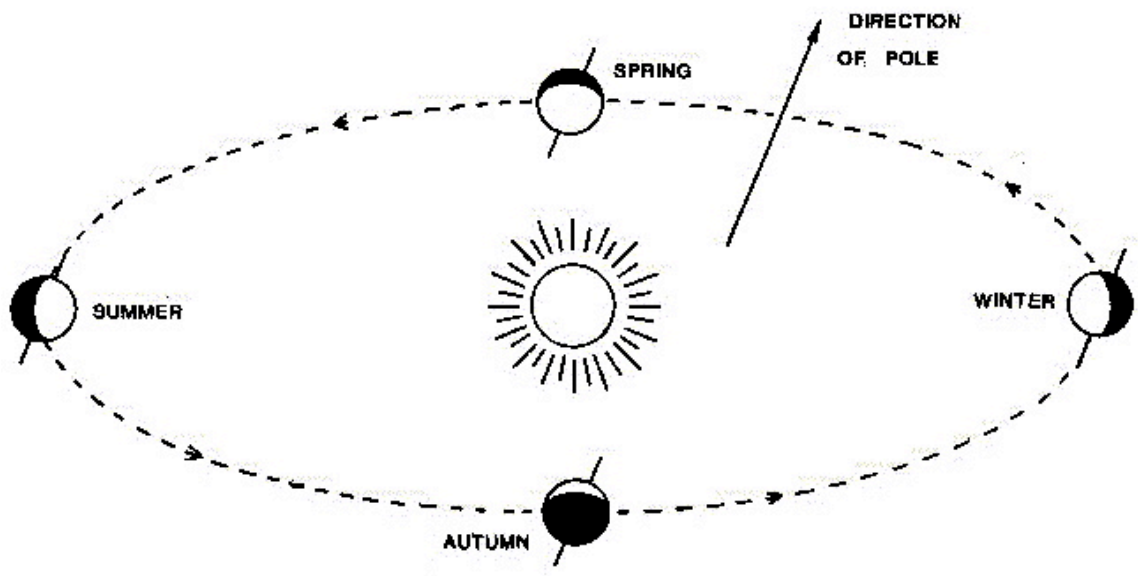
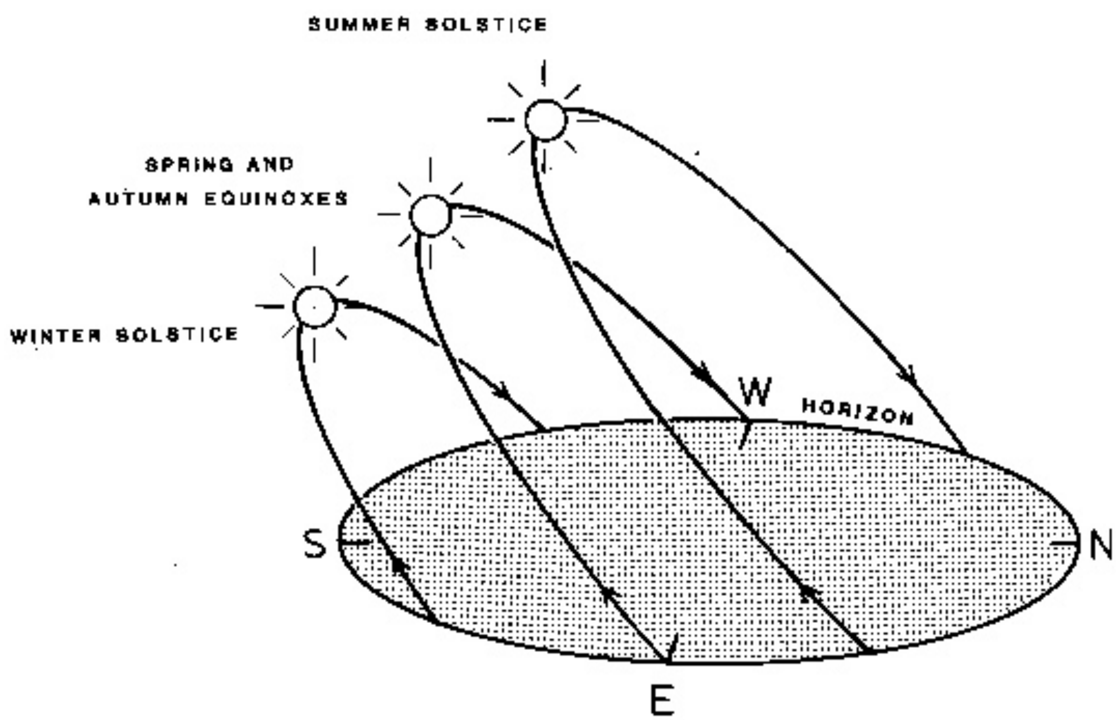


Figure 2.
The Suns changes its declination over the year and its daily path across the sky, rising higher during the summer months and lower in the winter months.



Recipes To Test!

1. Kale Chips
2. Baked Potato wedges
3. Roasted Nuts
4. Easy and healthy mini-pizza

Soil and Seeds: Teaching Kids the Ins and Outs of Farm Chores

Title Farm Chores: From Soil to Supper

Topic

In this lesson, kids will learn the ins and outs of growing vegetables and will be involved in every aspect of farm chores.

Standards

SC[00-08]S1,S2,S3,S4,S5,S6

Materials

-shovels and rakes
-compost
-seeds
-watering cans
-clippers

Objectives/ Outcomes

Students will be able to:

-prepare and till a garden bed, understand the importance of healthy soil and properly use garden tools
-plant a seed and understand what a plant needs to grow
-watch a plant as it grows and understand the plant's life cycle
-identify the difference between beneficial and non-beneficial insects
-determine when and how to harvest
-understand the nutritional value of vegetables

Intro

Who wants to be a farmer when they grow up? Well, you are going to learn all of the steps necessary to becoming a good farmer and most importantly you are going to learn how vegetables are grown and what they look like when they are growing. How many of you knew that growing food takes a lot of hard work? Most plans on the farm need to grow for 2-3 months before we ever get vegetables from them. Why is farming important? How are you influenced by farming? Where does your food come from? You are going to learn today that food does not come from the grocery store, but from the hard work of farmers all over the country and the world!

(mention a few farm rules to protect plants: walking feet on the pathways, etc...)

Activities

Prepare a garden bed

-Why do we prep/till a garden bed? To put air in the soil so that the roots of the plant will grow with ease. To de-clump and remove any rocks that may prevent the roots from growing properly, to add compost and improve the health of the soil for the next vegetable crop.

Plant a seed

-Identify the vegetable. For example: if you are planting a radish, make sure the students know its defining characteristics (look, taste, etc...).

-What is the first thing that you do when you plant a seed? How deep should your hole be? (3 times the width of the seed) A good rule of thumb for most seeds is the distance from the first bend to the tip of your finger, or the length of your finger nail. What would happen if you plant your seed too deep?

-Dig your hole.

-Hand out seeds.

-Ask students to look at their seed. Emphasize that they are holding a living thing in their hand but right now it is asleep and they are going to wake it up by giving the seed the things that it needs to grow. Have them plant their seeds, make a wish, and lightly cover their seed with the soil.

-What are the 5 things a seed needs to grow, what is going to wake up your seed? Soil, sun, water, air, and love. Discuss how their seed is going to get all of these things.

-Show kids a diagram of how their seed is going to grow and have them identify different parts of the plant and describe plant life cycle.

Harvest a vegetable:

-How do we know when a vegetable is ready to be harvested? You can usually tell by its size and color. Seed packet usually gives some information on when to harvest, or you could use a vegetable encyclopedia.

-What part of the plant are you eating?

-Wash and taste. What does it taste like? Why is it good for you?

Plant identification:

-Walk kids around the garden and have them observe and identify what they see. This can be anything from the vegetable to an insect and should lead to conversations about the relationships between different things in the garden.

Conclusion Students should understand the basics of farming

Resources MHS Kids Publishing Botany Flip Chart available at
www.ibotz.com/ biology/plant-biology/botany-flip-chart.html

The Encyclopedia of Natural Insect & Disease Control, edited by Roger B. Yepsen, Jr.

Rodale's All-New Encyclopedia of Organic Gardening

Carrots Love Tomatoes, Louise Riotte

Kid friendly tools available at Lowes

Supersalad?

Title: Supersalad?

Topic: The Science of Salad Dressing

Standards:

SC[04-08]-S1,S2,S3-
SCHS-S1,S3-
M[04-06]-S3,
S4,S5-
M[07-HS]-
S3,S4,S5-
ET[04-HS]-S1,S3-
Health[04-HS]-
S1,S3,S5,S6,S7,S8

Objectives/Outcomes:

Students will be able to…

- Predict the purposes of common food additives in salad dressing
- Demonstrate the purposes of said food additives
- Create their own salad dressings (at least one), demonstrating comprehension of the science of emulsions
- Generate questions on the effects of food additives
- Compare cost of store-bought dressing vs. fresh dressings
- Identify various additional everyday foods that are emulsions
- List common acids and bases used in salad dressing

Materials:

- Wish-Bone Balsamic Vinaigrette bottle
- Two cards for each of the following 16 ingredients (16x2=32 total cards): water, balsamic vinegar, soybean oil, extra virgin olive oil, sugar, salt, spices, caramel color, xanthan gum, sodium benzoate, sorbic acid, calcium disodium edta, citric acid, natural flavor, sulfur dioxide, annato extract
- Mystery box
- Cloth to cover salad/dressing table
- Salad dressing directions/recipe

Intro:

Here's the plan for today: First, I'm going to confuse you. Then I'm going to give you a chance to make sense of that confusion, but leave you completely confused. Then I'll reveal the mystery that lead to this confusion and Liz will teach you how to avoid said confusion, preventing any further confusion. Then, if you're lucky, you'll get to go out and confuse your parents, siblings, and peers. Any questions?

Activity 1: "Food" Card Game (It's similar to catch phrase)

- Goal/Rules of the Game: Find your partner (the person who has the same card as you). Note to instructor: They will then be partners during the demo.
- The catch? You may only describe the food item on your card. You may not use any words written on the card. You may not show anyone the card.
- Once you've found your partner, stand together off to the side and wait.

- Note: For kicks and giggles, tell them the food items on the cards are very commonly eaten, and it should thusly be easy to find their partner. (It's NOT)
- Begin the game. Once confusion sets in, intervene. Allow them to read/show their cards to each other in order to find their partner as necessary.

Activity 2: Full Ingredients List

- Now show them a full list of the ingredients and give each group of two "37 seconds" to come up with their best guess as to what these 16 ingredients combine to create.
- Finally, challenge someone to come eat whatever is in the mystery box, making certain they're aware that its contents could be anything from toe jam to maggots! Reveal the contents (Wish-Bone Balsamic Vinaigrette)

Activity 3: Discussing, Miming, and Speculating Effects Food Additives

- Have partners find another group of partners so that they are in groups of 4. Have them predict what role the ingredients play in Wish Bone Balsamic Vinaigrette.
- Facilitate brief group discussion.
- Reveal actual purpose of food additives (have them write these down) and ask each group to come up with ways to act out (or mime, rather) their purposes.
- Then, give each group a card (or a few), with said food additives, so that each group has different additives. One by one, each group will mime their food additives, while the others must guess which additive they're miming. (Warning: this could get a bit ridiculous! But as long as they're on track, let 'em go with it!)
- Lead discussion about the known (or unknown) effects of food additives. Have them read a brief portion of a research/legal document from the FDA on a common food additive.

Activity 4: Prepare a Salad and Homemade Salad Dressing

- There are endless combinations of vinaigrettes to create; but a good rule of thumb is offered on the small green handout provided*. Other sources would suggest using 1/3 parts oil. What makes this great is that this is a wonderful "trial and error" opportunity until they find what suits their pallet!
    - Math Challenge: Creating grade-level appropriate equations/problems to reveal the amounts needed can give math a purpose, silly as it may seem.
        - For example: 8*8-9*11+36=2x where x=cups of olive oil
        - You could also ask them to create a dressing that's tasty to them, then have them calculate proportions to create the same salad dressing, but in the amount of 16 fl oz (a typical size bottle of vinaigrette), and even have them do a cost comparison or homemade vs. store-bought dressings.
- Combine ingredients and shake vigorously until you've got a temporary emulsion. Adding raw honey not only adds sweetness to the dressing, but also thickens the dressing and lengthens the duration of the temporary emulsion.
- Note: the best way to sample a vinaigrette (to see if anything other ingredients should be added) is to dip a leaf of lettuce into the dressing, shake off excess, and take a bite, rather than using your finger.

Conclusion / Activity 5: Food Card Game #2

- Play the same game as above but with ingredient cards for the salad/dressing we just made. Note: with older students, it may be more interesting to vary game play—playing as you would play "Catch Phrase"—by passing the pile of cards from one person to the next with each correct answer.
- Show each student the full ingredients list #2 and let them guess what the ingredients combine to create, as before (no need for partner discussion).
- Once they've guessed correctly, draw to their attention that a list with fewer ingredients creates an entire salad + dressing! Also draw to their attention that they probably know what (nearly) all of the ingredients are, based solely on common sense.

Resources:

- http://www.cspinet.org/reports/chemcuisine.htm#sodiumb
- http://ag.arizona.edu/pubs/health/foodsafety/az1082.html
- http://www.fda.gov/Food/FoodIngredientsPackaging/FoodAdditives/FoodAdditiveListings/ucm091048.htm

Food Additives: (detailed descriptions seen below are available for all additives at cspinet.org)

- *Xanthan gum* - an emulsifier, flavor enhancer, formulation aid, humectant, stabilizer and thickener, synergist, and texturizer in food
- *sodium benzoate* – preservative
- *caramel color* – color additive
- *sorbic acid* – preservative
- *calcium disodium edta* - ?
- *citric acid* - Acid, flavoring, chelating agent
- *natural flavor* - flavor enhancer
    - Hundreds of chemicals are used to mimic natural flavors; many may be used in a single flavoring, such as for cherry soda pop. Most flavoring chemicals also occur in nature and are probably safe, but they are used almost exclusively in junk foods. Their use indicates that the real thing (often fruit) has been left out. Companies keep the identity of artificial (and natural) flavorings a deep secret. Flavorings may include substances to which some people are sensitive, such as MSG or HVP.
- *sulfur dioxide* – Preservative, bleach: Dried fruit, wine, processed potatoes.
    - Sulfiting agents prevent discoloration (dried fruit, some "fresh" shrimp, and some dried, fried, or frozen potatoes) and bacterial growth (wine). They also destroy vitamin B-1 and, most important, can cause severe reactions, especially in asthmatics. To non-sensitive individuals, sulfites are safe. If you think you may be sensitive, avoid all forms of this additive, because it caused at least twelve identifiable deaths in the 1980s and probably many, many more in the preceding decades. Deaths and less severe reactions were linked most commonly to restaurants foods. Sulfite levels in the lettuce and potatoes served at restaurants were often extremely high, because workers would allow the vegetable to sit in a sulfite solution for far too long a time. As a result of pressure from the Center for Science in the Public Interest (CSPI), a congressional hearing, and media attention, the FDA banned the most dangerous uses of sulfites and required that wine labels list sulfite, when used. Since those actions, CSPI has not been aware of any additional deaths.

annato extract - **Natural coloring:** butter, cheese, other foods.

- Annatto is a widely used food coloring obtained from the seeds of a tropical shrub. Its hue is yellow to orange. Unfortunately, natural does not always mean perfectly safe. Annatto causes hives in some people. In fact, allergic reactions to annatto appear to be more common than reactions to commonly used synthetic food dyes.

The Safety of Food Additives

CAMPUS HEALTH SERVICE
THE UNIVERSITY OF ARIZONA

Ever read the ingredient list of your favorite cereal? Or bread? Or frozen meal? Or protein bar? Check it out! There are TONS of additives out there—some of them are safe and some aren't. Use this guide to identify additives that you should be avoiding so that you can be a better educated consumer.

Safe

- ALPHA TOCOPHEROL (Vitamin E)
- AMYLASE
- ASCORBIC ACID (Vitamin C)
- ASCORBYL PALMITATE
- BETA-CAROTENE
- CALCIUM PROPIONATE
- CALCIUM STEAROYL LACTYLATE
- CARBON DIOXIDE (CARBONATED WATER)
- CELLULOSE
- CARRAGEENAN
- CITRIC ACID
- CYSTEINE
- DEXTRIN
- DIACYLGLYCEROL
- EDTA
- ERYTHORBIC ACID
- FERROUS GLUCONATE
- FOOD-STARCH, MODIFIED
- FUMARIC ACID
- GELATIN
- GLYCERIN (Glycerol)
- GUMS: Furcelleran, Ghatti, Guar, Karaya, Locust Bean, Xanthan
- HIGH MALTOSE CORN SYRUP
- INULIN
- ISOLATED SOY PROTEIN, TEXTURED VEGETABLE PROTEIN
- ISOMALT
- LACTIC ACID
- LECITHINMAGNESIUM COMPOUNDS
- MALIC ACID
- MALTODEXTRIN
- MONO- and DIGLYCERIDES
- NIACIN (VITAMIN B3)
- OAT FIBER, WHEAT FIBER
- OLIGOFRUCTOSE
- PANTOTHENIC ACID (AND SODIUM PANTOTHENATE)
- PAPAIN
- PECTIN (AND SODIUM PECTINATE)
- PHOSPHORIC ACID
- PHYTOSTEROLS and PHYTOSTANOLS
- POLYGLYCEROL POLYRICINOLEATE(PGPR)
- POLYSORBATE 60
- POTASSIUM CHLORIDE
- PYRIDOXINE (VITAMIN B6)
- RIBOFLAVIN (VITAMIN B2)
- SODIUM CARBOXY-METHYLCELLULOSE (CMC)
- SODIUM ERYTHORBATE, ERYTHORBIC ACID, SODIUM ISOASCORBATE
- SODIUM PECTINATE
- SODIUM STEAROYL LACTYLATE
- SORBIC ACID
- SORBITAN MONOSTEARATE
- STARCH and MODIFIED STARCH
- STEARIC ACID
- SUCRALOSE
- TARTARIC ACID, POTASSIUM ACID TARTRATE, SODIUM POTASSIUM TARTRATE, SODIUM TARTRATE
- TAURINE
- THIAMIN MONONITRATE
- TRIACETIN (GLYCEROL TRIACETATE)
- VANILLIN, ETHYL VANILLIN
- VEGETABLE OIL STEROLS
- VITAMIN B2 (RIBOFLAVIN)
- VITAMIN B6(PYRIDOXINE)
- VITAMIN E (ALPHA TOCOPHEROL)
- VITAMIN D (D3)

Cut Back

- CORN SYRUP
- DEXTROSE (CORN SUGAR, GLUCOSE)
- FRUCTOSE
- HIGH-FRUCTOSE CORN SYRUP
- HYDROGENATATED STARCH HYDROLYSATE
- INVERT SUGAR
- LACTITOL
- MALTITOL
- MANNITOL
- POLYDEXTROSE
- SALATRIM
- SALT
- SORBITOL
- SUGAR
- TAGATOSE
- XYLITOL

Certain People Should Avoid

- NATURAL FLAVORING: Annatto
- BENZOIC ACID
- CAFFEINE
- CARMINE/COCHINEAL
- CASEIN
- GUARANA
- GUM ARABIC (ACACIA)
- GUM TRAGACANTH
- HVP (HYDROLYZED VEGETABLE PROTEIN)
- LACTOSE
- MSG (MONOSODIUM GLUTAMATE)
- MYCOPROTEIN/QUORN
- QUININE
- SODIUM BENZOATE
- SODIUM BISULFITE
- SODIUM CASEINATE
- SULFITES
- SULFUR DIOXIDE

Caution

- ARTIFICIAL COLORINGS: BLUE 1, Citrus Red 2, RED 40
- BROMINATED VEGETABLE OIL (BVO)
- BUTYLATED HYDROXYTOLUENE (BHT)
- DIACETYL
- HEPTYL PARABEN
- STEVIA, REBIANA

Avoid

- ACESULFAME-K
- ARTIFICIAL COLORINGS: BLUE 2, GREEN 3, ORANGE B, RED 3, YELLOW 5, YELLOW 6
- ASPARTAME (Nutrasweet)
- BUTYLATED HYDROXYANISOLE (BHA)
- CARAMEL COLORING
- CYCLAMATE (not legal in U.S.)
- OLESTRA (Olean)
- PARTIALLY HYDROGENATED VEGETABLE OIL (TRANS FAT)
- POTASSIUM BROMATE
- PROPYL GALLATE
- SACCHARIN
- SODIUM NITRATE
- SODIUM NITRITE

Modified from the Center for Science in the Public Interest, for more information: http://www.cspinet.org/reports/chemcuisine.htm

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Sample descriptions from the Center for Science in the Public Interest:

SODIUM BENZOATE, BENZOIC ACID

Preservative: Fruit juice, carbonated drinks, pickles.

Preservative

Manufacturers have used sodium benzoate (and its close relative benzoic acid) for a century to prevent the growth of microorganisms in acidic foods. The substances occur naturally in many plants and animals. They appear to be safe for most people, though they cause hives, asthma, or other allergic reactions in sensitive individuals.

Another problem occurs when sodium benzoate is used in beverages that also contain ascorbic acid (vitamin C). The two substances, in an acidic solution, can react together to form small amounts of benzene, a chemical that causes leukemia and other cancers. Though the amounts of benzene that form are small, leading to only a very small risk of cancer, there is no need for consumers to experience any risk. In the early 1990s the FDA had urged companies not to use benzoate in products that also contain ascorbic acid, but in the 2000s companies were still using that combination. A lawsuit filed in 2006 by private attorneys ultimately forced Coca-Cola, PepsiCo, and other soft-drink makers in the U.S. to reformulate affected beverages, typically fruit-flavored products.

CARAMEL COLORING

Coloring: Colas, baked goods, pre-cooked meats, soy and Worcestershire sauces, chocolate-flavored products, beer.

Coloring

Caramel coloring is made by heating a sugar compound (usually high-dextrose corn syrup), often together with ammonium compounds, acids, or alkalis. It is the most widely used (by weight) coloring added to foods and beverages, with hues ranging from tannish-yellow to black, depending on the concentration and the food. Caramel coloring may be used to simulate the appearance of cocoa in baked goods, make meats and gravies look more attractive, and darken soft drinks and beer.

Caramel coloring, when produced with ammonia, contains contaminants, 2-methylimidazole and 4-methylimidazole. In 2007, studies by the U.S. National Toxicology Program found that those two contaminants cause cancer in male and female mice and possibly in female rats. In 2011, the International Agency for Research on Cancer, a division of the World Health Organization, concluded that 2- and 4-methylimidazole are "possibly carcinogenic to humans." Then, the State of California's Environmental Protection Agency listed ammonia-caramel coloring as a carcinogen under the state's Proposition 65. The state lists chemicals when they pose a lifetime risk of at least 1 cancer per 100,000 people. California warned that as of January 7, 2012, widely consumed products, such as soft drinks, that contained more than 29 micrograms of 4-methylimidazole per serving would have to bear a warning notice. In March 2012, when CSPI published the results of a study that found levels up to 150 micrograms per can of Coca-Cola and Pepsi-Cola purchased in Washington, DC, the soft-drink giants announced that they had reduced the contaminant to below California's threshold for action in products distributed in California. They said they would market the less-contaminated products throughout the country, but did not give a timetable for that change.

The FDA has a limit that is 10 times as strict as California's for regulating chemicals that are contaminated with cancer-causing chemicals. CSPI's analysis of a Coca-Cola purchased in 2012 in California found just 4 micrograms of 4-MI per 12 ounces. Even that much lower level might exceed the FDA's threshold for action of 1 cancer per million consumers.

It would be worth avoiding or drinking less colas and other ammonia-caramel-colored beverages not only because of risk from the 4-methylimidazole, but, of course, because the products contain about 10 teaspoons of sugar per 12 ounces and promote obesity and tooth decay. Soy sauces, baked goods, and other foods that contain ammoniated caramel coloring are much less of a problem, because the amounts consumed are small.

The FDA explains calcium disodium edta:

Calcium disodium ethylenediamine-tetraacetate [(calcium ethylenedinitrilo) tetraacetate]; calcium disodium EDTA - AF, REG, 25 ppm - Fermented malt beverages - 172.120; Antigushing agent; MISC, 60 ppm - Spice extractives in soluble carriers; Color & flavor; 100 ppm - Pecan pie filling, promote color retention; 340 ppm - Clams (cooked-canned), promote color retention; 800 ppm - Dry Pinto beans, promote color retention; 310 ppm - Promote color retention in dried lima beans (cooked, canned); 275 ppm -Crabmeat (cooked- canned), retard struvite formation, promote color retention; 250 ppm - Shrimp (cooked-canned), retard struvite formation, promote color retention; 33 ppm - Promote flavor in carbonated soft drinks; 110 ppm - Promote color retention in canned white potatoes; 200 ppm - Mushrooms (cooked, canned); 220 ppm - In pickled cucumbers or pickled cabbage; To promote color, flavor & texture retention; 100 ppm - Promote color retention in artificially colored lemon-flavored and orange-flavored spreads; 100 ppm - Potato salad, preservative; 75 ppm alone or comb with disodium EDTA - French dressing, mayonnaise, and salad dressing; non-standardized dressings and sauces, preservative; 100 ppm alone or comb /w disodium EDTA - Sandwich spread, preservative; 200 ppm by wt of egg yolk portion - Egg product that is hard-cooked & consists, in a cylindrical shape, of egg white w/an inner core of egg yolk, preservative; 25 ppm - In distilled alcoholic beverages - 172.120, promote stability of color, flavor and or product clarity; PRES, REG/MIA, 75 ppm - Oleomargarine - Part 166; 365 ppm - Promote color retention in legumes (all cooked canned, other than dried lima beans, pink beans and red beans) - 172.120

Tucson Village Farm

Simple Salad Dressing

Basic Ingredients:

Combine equal parts base

Such as Olive, Walnut, or Grapeseed Oil

With an acid

Vinegars, Lemon Juice, Lime Juice

Then add flavors to taste (start with just one or two until)

Herbs, spices, salt, pepper, honey, mustard

Use your creativity to create a variety of flavorful salad dressings!

Example recipe:

½ cup olive oil

½ cup balsamic vinegar

½ teaspoon mustard

½ teaspoon honey

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Water

Extra Virgin
Olive Oil

Balsamic
vinegar

Salt

Soybean oil

Spices

Sugar

Caramel
Color

Xanthan gum

Calcium disodium edta

Sodium benzoate

Natural flavor

Sorbic acid

Sulfur dioxide

Citric acid

Annatto extract

Full list of ingredients #1:

1. Water
2. Balsamic vinegar
3. Soybean oil
4. Extra virgin olive oil
5. Sugar
6. Salt
7. Spices
8. Caramel color
9. Xanthan gum
10. Sorbic acid
11. Sodium Benzoate
12. Calcium disodium edta
13. Citric acid
14. Natural flavor
15. Sulfur dioxide
16. Annato extract

Refined olive oil

Greens

Extra Virgin olive oil

Chives

Concentrated cooked grape must

Radishes

Red wine vinegar

Carrots

Pepper

Local Raw Honey

Full list of “real” ingredients #2:

1. Refined olive oil
2. Extra virgin olive oil
3. Concentrated cooked grape must
4. Red wine vinegar
5. Greens
6. Chives
7. Radishes
8. Carrots
9. Pepper
10. Local raw honey

The Poop on Worms

Title: **Your Own Personal Worm Bin**

Topic: Vermicomposting and the waste stream

Standards: M[00-05]-S1, S2, S3, S5
SC[00-05]-S1, S3, S4, S5

Materials:
- Small plastic bin
- Bedding for worms (shredded newspaper, toilet paper tubes, brown leaves, straw)
- Food waste (inedible parts of vegetables, old fruits, non-meat, non-oily, non-dairy leftovers)
- Scale
- Worms!
- Spray bottle
- Worm care log

Objectives/Outcomes:

Students will be able to:
- Analyze their personal impact upon the waste stream
- Observe, measure and record the progress of their worm bin
- Demonstrate the relationship between inputs and outputs, i.e. the health of their worms as connected to decisions made about care for their worms
- Understand how to employ ratios and division to input appropriate quantities

Intro:

Did you know that each person in the US produces almost four and one half pounds of trash a day (*source: EPA)*? That's 250 million *tons* of trash a year. All of that material has to go somewhere, and most of it finds its way to a landfill and just sits. What if there was a way to keep some of that trash from just sitting around for longer than it needs to? Nature has a way of dealing with its "trash" - decomposition. One of nature's best decomposers are worms. These little guys munch through organic material as if their life depends on it - because it does! Worms use this material as their food. More than half of the stuff in our landfills (paper products, food scraps, yard trimmings) could be eaten up by worms and turned into garden gold - worm poop(*source: EPA)*! How much trash could we prevent from ending up in landfills if each of us kept our own colony of worms?

Activities:

1) How much trash do I *produce?*

a) Rather than throwing your trash away for twenty-four hours, have each of your students save it in a grocery bag. Weigh each of these.
b) Use multiplication to figure out how much trash that amounts to in a year per person, in a day as a group, in a year as a group, etc.
c) Using what students have learned about worms, have them divide their trash into trash that worms can eat and trash that they cannot eat. Figure out what percentage of their trash this is.
d) Figure out how much trash they would remove from the waste stream by vermicomposting this trash rather than throwing it away. Extrapolate these numbers similarly to in *c)*.

2) How many worms do I need?

a) Using calculations from activity *1),* have students determine the amount of worms
they need to be food-waste free. Take the volume of food and waste multiply by two.
This is the volume of worms students will need.
b) Have students estimate how many worms will constitute the proper volume.
c) Weigh a worm and divide the ideal volume by this number to determine how many worms a students will need.
d) Remember that worms reproduce quickly! If properly taken care of, a population could double in thirty days.

3) *Constructing my worm bin*

a) Using calculations from previous activities, determine the volume required for a
properly sized worm bin.
b) Determine the proper volume for a worm bin of a realistic size for your class members to take care of (i.e. a small ~ 6” x 12” plastic storage bin)
c) Apply bedding.
d) Drop worms in.
e) Moisturize bedding with spray bottle

4) *Worm Log*

a) Have students create a gridded Worm-care-log

b) Send students home with worm bin to create a record of nutrients input and output of the health of the worms. They should record each feeding and a brief observation of the health of their colony.

Conclusions:

By using vermicomposting, everyone can remove a significant portion of their contribution to the waste stream. This can be maximized by using observation to create an ideal environment for one's worm colony. Some care must be taken, but natural processes will happen regardless of intervention, and as stewards we must simply encourage these processes.

Homework:

a) bring compostable waste into class.
b) Care for worms.
c) Record daily inputs and outputs of worm colony.

Weather to be or not to be…

How to make weather instruments in the classroom

Topic-Measurement

Standards

Rain Gauge

How much rain is really falling when you watch a heavy shower through the window of your home? How about on other days when it’s just a light shower?

Find out by making your own rain gauge, recording the results and studying your findings.

Materials

- A plastic (soft drink) bottle
- Some stones or pebbles
- Tape
- Marker (felt pen)
- A ruler

Directions

- Cut the top off the bottle.
- Place some stones in the bottom of the bottle. Turn the top upside down and tape it to the bottle.
- Use a ruler and marker pen to make a scale on the bottle.
- Pour water into the bottle until it reaches the bottom strip on the scale. Congratulations, you have finished your rain gauge.
- Put your rain gauge outside where it can collect water when it starts raining. After a rain shower has finished, check to see how far up the scale the water has risen.

Wind speed Challenge

An anemometer will help show you how fast the wind is going by spinning cups around. The faster the wind is moving the faster the cups will spin.

Materials

- Paper cups
- A skewer (or something similar to poke holes)
- Straws
- Scissors
- A marker (felt pen)
- Tape or glue
- A chunk of wood with a hole in it (optional)

The Challenge

Your challenge is to design something that can measure the wind speed. Create an anemometer that features free spinning cups that spin faster as the wind increases. The wind should blow into the cups pushing them away. The faster the wind the more force it has to push the cups and the faster they spin. You can measure the wind strength by comparing how many times the anemometer spins around every 10 seconds. Does it vary from place to place and day to day?

Make Your Own Barometer

What you'll need

- A balloon
- Scissors
- A jar
- A rubber band
- Tape
- A straw
- A piece of card
- A marker (felt pen)

Instructions:

1. Cut the top off the balloon (the part which you blow into).
2. Stretch the balloon over the top of the jar and hold it in place with a rubber band.
3. Place the straw across the top of the jar so that one third of the straw is hanging over the edge. Stick the straw to the balloon with tape.
4. Draw three lines on the piece of card that are about half a centimeter apart from each other. Label these lines as high, moderate and low.
5. Tape the card against the back of the jar so that the straw points to moderate.
6. Put your barometer on a flat surface somewhere inside.

What's happening?

When there is low air pressure the balloon should expand out and the straw will point down. This is because the air inside the balloon now has relatively more air pressure compared to the air outside, it pushes the balloon out as a result.

When there is high air pressure the air on the outside will push the balloon into the jar and the straw will point upwards. The air inside the balloon now has relatively less pressure, this pushes the balloon inwards as a result.

In general, high air pressure indicates fair weather while low air pressure indicates that bad weather is more likely. Although forecasting the weather isn’t an exact science and can be very difficult at times, give it a go and see how accurate you are.

Conclusion-Although these weather instruments are crude there are further steps the students can take to calibrate and calculate what is actually happening outside. Wunderground.com is an excellent site to find specific weather information. To do this, go the site and find your city, then click on the WunderMap icon next to the radar section. From here you can zoom in on your city and find a weather station near to your location (you can also find the Tucson Village Farm weather station). With this information your students can see what there readings translate into and know how to read future readings.

Additional Resources
A great site for current weather conditions http://www.wunderground.com/
Apply to win a free weather station for your school
http://www.wunderground.com/blog/gardeneducator/comment.html?entrynum=0
How to make more weather instruments http://www.kidsgardening.org/classroom-projects/making-weather-tracking-tools
Weather information for kids http://www.weatherwizkids.com/weather-forecasting.htm
Weather games http://www.theweatherchannelkids.com/weather-games/ and http://www.edheads.org/activities/weather/

It's so cold I might just pop!

Topic-The physics of water and what that can mean to plants

Materials

- 2 small pieces of bubble wrap cut into the shape of a leaf (green if possible)
- 2 identical containers with lids. Freeze 1 container and make sure the lid pops off or the container ruptures. Refrigerate the other (refrigeration is optional)
- 1 container filled to the brim with water and frozen. Make sure this container does not rupture. A pleated water bottle or a bottle with contours works well.

Intro

- We will be investigating why cold temperatures do little damage to plants while freezing temperatures can cause major damage.

Activity

- Before we start we must first understand a few things about water. If there is a cup of warm water sitting on the table and we make it colder, the water will become slightly smaller. We cannot always see it shrink but it does. When the water starts to freeze it gets a tiny bit bigger. This change is very small but you will see why this is important in a minute. (Have the students act out what water does in a game format, after a few rounds the kids will understand).
- A few things about plants. Plants are made of cells. Use the bubble wrap in the shape of the leaf to show the students how on the outside it is smooth. But on the inside, there are lots of tiny containers called cells. All plants are made of cells and these cells are filled with water. Some cells are strong and other cells are not as strong. Point to a bubble in the bubble wrap and ask the kids to act out a cell being strong and weak.

Time to Combine

- Review what the students know so far. Does water get bigger or smaller when it freezes? Does water get bigger when it is just cold but not frozen? Is a plant made up of tiny little containers? What are these tiny containers filled with?
- Bring out the 2 frozen containers and the refrigerated one. Explain that these containers are a bigger version of the bubbles on the bubble wrap (cells). Holding the frozen container that burst. Ask if anybody can figure out what happened. Use this answer or lack of answer to explain the basic info again. Repeat with the refrigerated water and the unbroken frozen container. Ask why one burst and not the other etc. (If possible, tell the kids that it is the sharp ice crystals which puncture the cell and not only the expansion of the water)

<u>Conclusion</u>

Some plants have a hard time with the cold because their cells are not strong enough to withstand the increased size of the water (or the sharp ice crystals). When the plant thaws out, all of its water pours out of the cells and that part of the plant dies. If the cells in the leaf lose the water, the cell will die and if the cells die the leaf cannot survive.

Food Mapping

Food Mapping

Topic:
What is the difference between a store-bought apple and the one you bought from the farmers market? Who grew it? Where did it come from? Introduce and become familiar with local and global aspects of the food system by tracing the various steps our food goes through before arriving at our table. Examine the cost and effects this complex system has on our environment, people, and the economy. Apply your newfound knowledge by completing the food map obstacle course to demonstrate the energy consumed by local versus global foods while getting a compelling workout.

Standards:

SC[06-08]-S2,S3,S6
SCHS-S3,S6
M[06-HS]-S1,S2

Materials:

- A potato produced outside the state or country (farther away the better) and a potato from your local farmer or farmers market (as local as possible)
- Local and national road maps
- Writing board and markers
- Paper and pens/pencils
- Scissors
- Glue
- *Food System Map* materials:
    - *Sustainable* handout
    - *Conventional* handout
- *Trace the French Fry Quote* sheets (conventional and sustainable)
- *Energy used in producing food* handout
- *Work it out!* handout
- Produce section from local newspaper

Objectives/Outcomes:
Students will be able to:

- Describe how the steps in the food system are interrelated
- Decipher the concepts "Local" "Regional" and "Global" food system, along with understanding all food systems, community or conventional.
- Trace how energy is needed and used in the food system
- List and explain how our food choices can affect the community system, global system, and the environment
- Track produce to better understand distance traveled
- Use division to help complete obstacle course

Intro:

In order to understand food systems and how they are interconnected, we must first understand the terms used. This lesson will help us define "local", "regional", and "global" for future use, along with learning about the amount of energy it take to produce food. Using a food system worksheet, we will calculate the distance a food travels. Using those numbers, we base how many exercise moves students will do to demonstrate the energy it takes a produce to travel to their table.

Activities:

1. Start the lesson by discussing or thinking about the meaning of the terms "Local" "Regional" and "Global". The distinctions between these different systems are base on the distances between the sources of the food (where it is grown, raised or caught) and the place where it is purchased for consumption.

Guiding Questions:

Using the guiding questions below, brainstorm to focus your ideas.
Referring to the background section for assistance.

- What do you think the terms "local" means?
- What produce grows well in your area? What produce does do very well in your area?
- What does the term "regional" mean to you?
- What is your region?
- What does the term "global" mean to you?
- What is a "global" food?

2. Hold up the two potatoes and ask, "What are the differences between these two potatoes?" There are several differences here, visible and invisible. Pass the produce around. Generate a list to get an idea of what the group thinks. If words like "organic" are thrown out, ask them to clarify.
3. Provide the group with more information by telling them where you bought or dug the potatoes and where the potatoes themselves originated. Tell the group that the potatoes come from two very different food systems. One potato was grown locally and represents a more sustainable food system, while the other came from a much farther away and represents the global, conventional food system.
4. Help the students define the phrase "food system". Ask them to list the parts of food system, and then help the group finish the definition. (The system that produces, processes, distributes and sells food.) Try defining a "system" first and then ask them to imagine what a "food" system could mean (According to Merriam-Webster Dictionary, Systems is defined: a regularly interacting or interdependent group of items forming a unified whole). Or, ask the group to imagine or even draw the path that their breakfast took to get to their table. What is your cereal made of (grain)? Where in the U.S. was the grain grown for your cornflakes (probably the Midwest)? What happened to grain after it left the farm (processed into flakes)? Just help set the general path.

5. Split the group in half and one group focus on the local potato and the other group focus on the conventional potato. Hand out the sustainable pieces to one group and the conventional to the other, along with the quote sheet. Explain to the two teams that their challenge is to develop a map of their particular food system by matching the quotes and names on the handouts to their role in the food system.
6. A team is done if they have set up all the cards and arrows in the correct order and are ready to paste them to the flip-chart. Have them do so. When done, the arrows link all the roles in the food system (producer to consumer). Each team will present its map. Have someone from the teams explain their system. Other team members can read the name of each food system player and their quote. Tell the other team to listen closely, because they must identify any mistakes. Ask the group if it knows which system produced which potato and why.
7. Hand out photocopies of Energy Used in Producing Food. Explain the map and ask them, How are these maps different from the one they just created? How are they similar?
8. Now think about impact within these food systems. What kind of impact or effect would each of these roles in the food system have on the environment or on the community? Help them to think about the impact in three categories: people, the environment and the economy. What types of impacts occur in each of these areas? To help stimulate this conversation, try to be specific and use of the background sheet may help to stimulate conversation. Ask the group to mentally trace where their breakfast came from this morning.
   Did your food come from far away or close by?
   What is the impact of trucking our food all over the country?
   What about the farms that produced the wheat for your bagel?
   Would they have any impact you might have heard about on the environment or laborers in their fields?
   **Semi-trucks are equipped with dual fuel tanks for balance, coming in three sizes: 100 gallons, 150 gallons, and 200 gallons, with an average of 6 mpg.
9. This would be a good opportunity for students to use Google Maps online to find the distance food traveled. If computers are not accessible, use local and national road maps. Now, how the students plot down the exact distance of the potatoes traveled using Food for Thought worksheet. Find other produce using your newspaper ads, see if you can discover if produce sold is grown locally, regionally or globally. Record 10 produce items that are being sold that week and record where they are grow. If you cannot find where they are grown, try to make an educational guess.
10. Now using the local and national road maps, figure out the distance the produce traveled. Continue to fill out the chart by dividing by 8, which represents the 8 stations students will participate in the obstacle course. Please tell student that each stations represents the conventional system in producing food: Growing the food; fuel to transport food to processor; processing the food; fuel to transport food to distributor; storing the food; selling the food; fuel to transport food to home; eating the food. Continuing with the chart, divide again by 10 (each station will represent 10miles) to find the total repetitions the student will perform at each station.
11. Set up the obstacle course by simply writing each exercise task down on a piece of paper and placing them on the floor forming a large circle. See example below.
12. Now each student will chose two produce on their table, the one with the longest distance and the one with the shortest distance. They must represent the distance each

produce by going throw the obstacle course doing as many repetitions their calculations determined.

13. After students go through the obstacle course at least twice have them cool down. Ask them how they feel and how much energy they put into the obstacle course. Was the shorter or longer distance better? What does this tell them about the local, regional, and global food system? If they were to perform the local food system obstacle course, how many stations would it have? Would it be easier or harder? How many repetitions do they think they would have to perform at each station?
14. Allow for open discussion on what they have learned. Ask them to explain how our food choices can affect the community system, global system, and the environment.

Conclusion:
This activity has introduced student to the complexities of the food system demonstrating local, regional, and global terms, along with other concepts involved in those systems. Students not only see the distance our food traveled in numbers, but they see the distance on a map and get a chance to experience the energy it takes to ship food through a physically challenging obstacle course. This helps students to fully understand the impact our food choices have on the community system, global system, and the environment.

Follow up:
If you want to spend more time investigating and defining the concept of a food system you can have them trace their whole breakfast and plot the distance of all food on a chart and then a map.

Citations:
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www.discoverfoodsys.cornell.edu

Jennifer Jensen, 2010. Local and Regional Food Systems for Rural Futures. Ruri Rural Futures Lab Foundation Paper No. 1
www.rupri.org

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www.leopold.iastate.edu

Background

Food systems can be characterized as, “local” “regional” and “global.” A food system involves the functions of production, processing, transportation, storage, marketing, preparation, consumption, disposal and decomposition. It can be visualized by imagining all the steps necessary for bringing food from the land or sea to the table and disposal of all. The distinctions between these different systems are based on the distances between the sources of the food (where it is grown, raised or caught) and the place where it is purchased for consumption. Another important distinction between these systems is the hidden costs and benefits of each that do not show up in the price we pay for food. For example, the global system uses anywhere from 4 to 7 times as much energy (fuel to transport the food), and produces 5 to 17 times more CO2 (from the burning of the fuel) than a local food system. Local food systems, or “community food systems” are thought to benefit the local economy by keeping food-related enterprises nearby and employing residents of a community, by keeping local farms in business, and by keeping the rural landscapes agricultural. In such a system, there is an emphasis on the development and maintaining of relationships between people in different sectors in the food system – farmers, processors, distributors, and consumer, for example.

Much of the food found in a grocery store arrived there through a food system that is **global**, which is a system geared towards a production model that requires maximizing efficiency in order to lower consumer costs and increase overall production. Local supermarkets are supplied by national and international sources. **Conventional Agriculture** a trend often identified as the industrialization of agriculture that soared after WWII due to new technologies, mechanization, increased chemical use, specialization and government policies that favored maximizing production. These changes allowed fewer farmers with reduced labor demands to produce the majority of the food and fiber in the U.S. Now a process by which fewer and much larger farmers are producing the majority of our food and corporations and multinational firms are controlling production operations. Also, Government subsidies for large-scale food production continue to make it hard for small producers to survive. For example, less than 20% of the largest farms in the U.S. are responsible for over 80% of total production. Less than 4% of the largest farms produce 66% of vegetables, sweet corn and melons. These farms, with their subsidies and poor farming practices, are putting the small family farmer out of business.

Regional food systems are based on the existing state distribution infrastructure. A cooperative network of state farmers that supply state retailers and wholesalers, distributed in large semi-trailer and mid-size trucks, characterizes a regional food system.

By contrast a **local food system** is one in which much of the food is marketed directly from farmers to consumers in order to sustain food production, processing, distribution and consumption to integrate and enhance the environment, economy, and social and nutritional health of a particular place. It describes a method of food production and distribution that is geographically localized, rather than national and/or international. Food is grown and harvested close to consumers' homes, then distributed over much shorter distances than is common in the conventional system. Commonly, local food is referred to food produced within 50-100 miles of the consumer. These regional food systems are being developed as a response to industrialized agriculture, driven by agribusiness and its impact on the environment, family farms, consumers, food safety and the quality of life in rural communities (Garrett and Feenstra. 1999). Because food is marketed directly, local food systems are generally confined to a relatively smaller geographic area – what can be delivered by truck within a few hours. Examples of local food systems include farmers' markets, roadside stands, on-farm sales, U-pick operations, production/processing/retail enterprises, and sales directly to hotels, restaurants, bed-and-breakfast inns, and institutions.

A **community-supported agriculture (CSA)** is a growing model of direct marketing currently utilized by many organic farms and an increasing number of small non-organic farms. In this model consumers buy shares in the farm in the beginning of the season or as part of a payment plan decided up on by the farmer. Shareholders receive a quantity of vegetables each week by going out to the farm for a pickup or at designated drop-off sites in their area. The CSA model is a form of direct marketing to the consumer and is economically viable for the farmer because it cuts out the middleman (distributor or wholesaler) and therefore allows the farmer to receive the full value that his or her produce is worth. CSA also provides consumers with the freshest vegetables possible and in some arrangements, the opportunity to visit and work on the farm.

Since certain areas of the country can produce large quantities of particular foods at low prices, much of the market for those foods has shifted to the global food system. When viewing the global system as a whole, it appears that production has increased to meet the demands of the population. Along with these changes, the distribution of farms and agricultural business has shifted as well. While the local food systems are participants in the global food systems, their contribution is diminishing because many smaller businesses are unable to compete with larger production farms in the country. The issues surrounding the globalization of our food system are complex and extensive. There are significant benefits to our global community while our local communities may experience many of the drawbacks of globalization (Harmon et al. 1999).

In the past 30 years there has been a significant global increase in fossil fuel use. One reason for the rise in U.S. fossil fuel use is the increased use of trucks to transport goods. In 1965, there were 787,000 combination trucks registered in the United States, and these vehicles consumed 6.658 billion gallons of fuel. In 1997, there were 1,790,000 combination trucks that used 20.3 billion gallons of fuel. Many of these trucks transport food throughout the country. A study conducted by the Center for Agricultural Business indicated that in California alone more than 485,000 truckloads of fresh fruit and vegetables leave the state every year and travel from 100 to 2,100 miles to reach their destinations.

The supply of fossil fuel to meet this increasing demand is one issue (the peak in oil production is predicted to already have occurred), but another important issue is the carbon dioxide (CO2) and other gases that are released when fossil fuels are used. These gases absorb heat and may contribute to an increase in global warming. As fuel use goes up, so does the release of CO2 and other gases. Total U.S. greenhouse gas emissions in 1999 were 11.6% higher than in 1990. The largest source of CO2 and overall greenhouse gas emissions in the United States was fossil fuel combustion, accounting for 80% of the global warming potential.

A **Food Mile** is the distance food travels from where it is grown or raised to where it is ultimately purchased by the consumer or other end-user. One 1969 estimate of miles traveled by food in the United States cited an average distance of 1,346 miles. Calculations in another study examining transportation and fuel requirements estimated that fresh produce in the United States traveled an estimated 1,500 miles. An analysis of the USDA Agricultural Marketing Service’s 1997 arrival data from Jessup, Maryland, found that the average pound of produce distributed at the facility traveled more than 1,685 miles, with the average distance for fruits being 2,146 and the average for vegetables 1,596 miles.

Work it out! Worksheet

- -

Produce Sold this week	Local	Regional	Global	Specific location	Total Distance Traveled /miles	Divide by 8 (total stations)	Divide by 10. Total Repetitions to perform at each station
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

Produce Sold this week	Local	Regional	Global	Specific location	Total Distance Traveled /miles	Divide by 8 (total stations)	Divide by 10. Total Repetitions to perform at each station
1.							
2.							
3.							
4.							
5.							
6.							
7.							
8.							
9.							
10.							

Example chart:

Produce Sold this week	Local	Regional	Global	Specific location	Total Distance Traveled /miles	Divide by 8 (total stations)	Divide by 10. Total Repetitions to perform at each station
1. Red delicious Apple			X	Washington State	1,500/miles	187.5	18.75~=19 repetition to be performed at each obstacle station

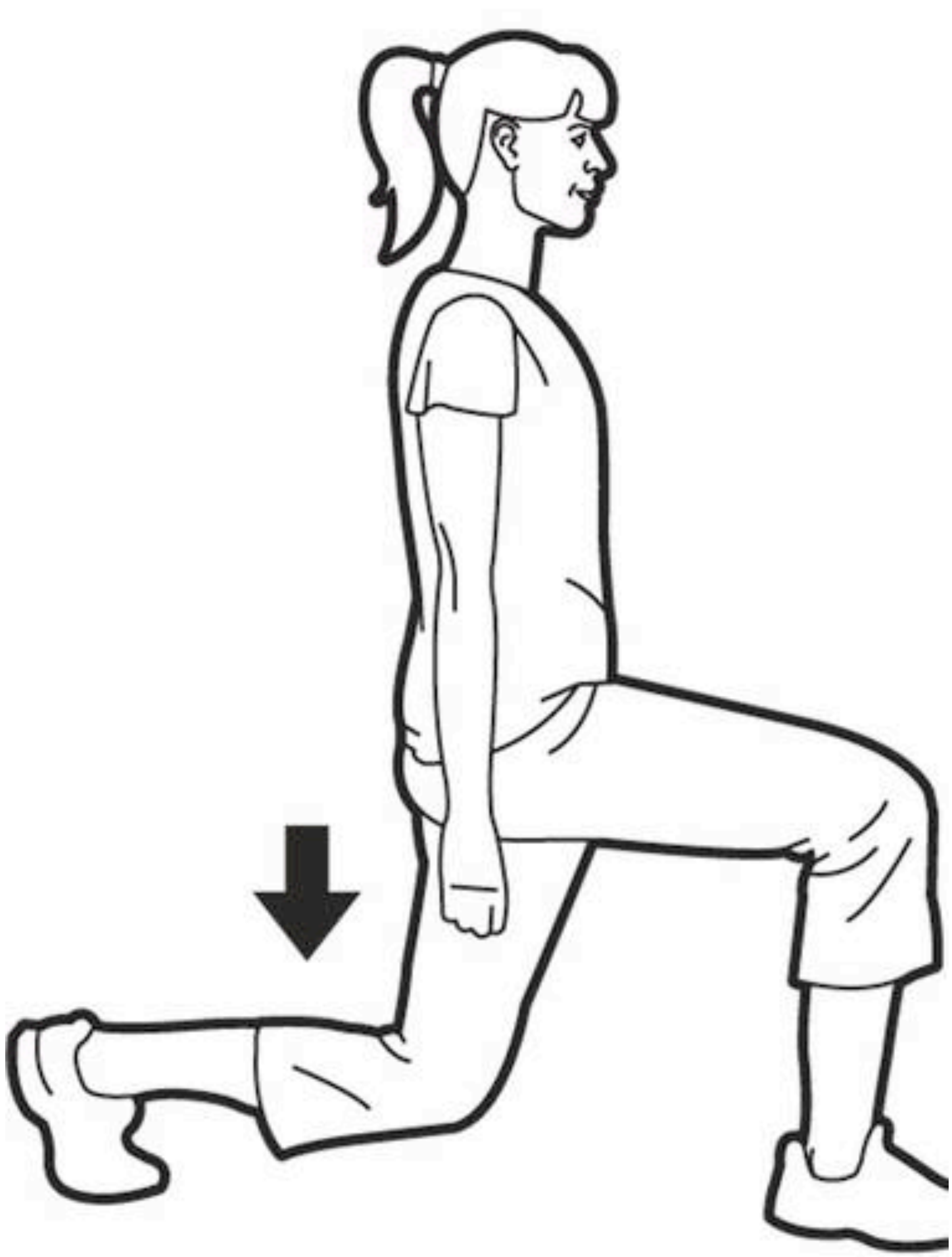
Obstacle Course Stations and Set-up:

Start! →

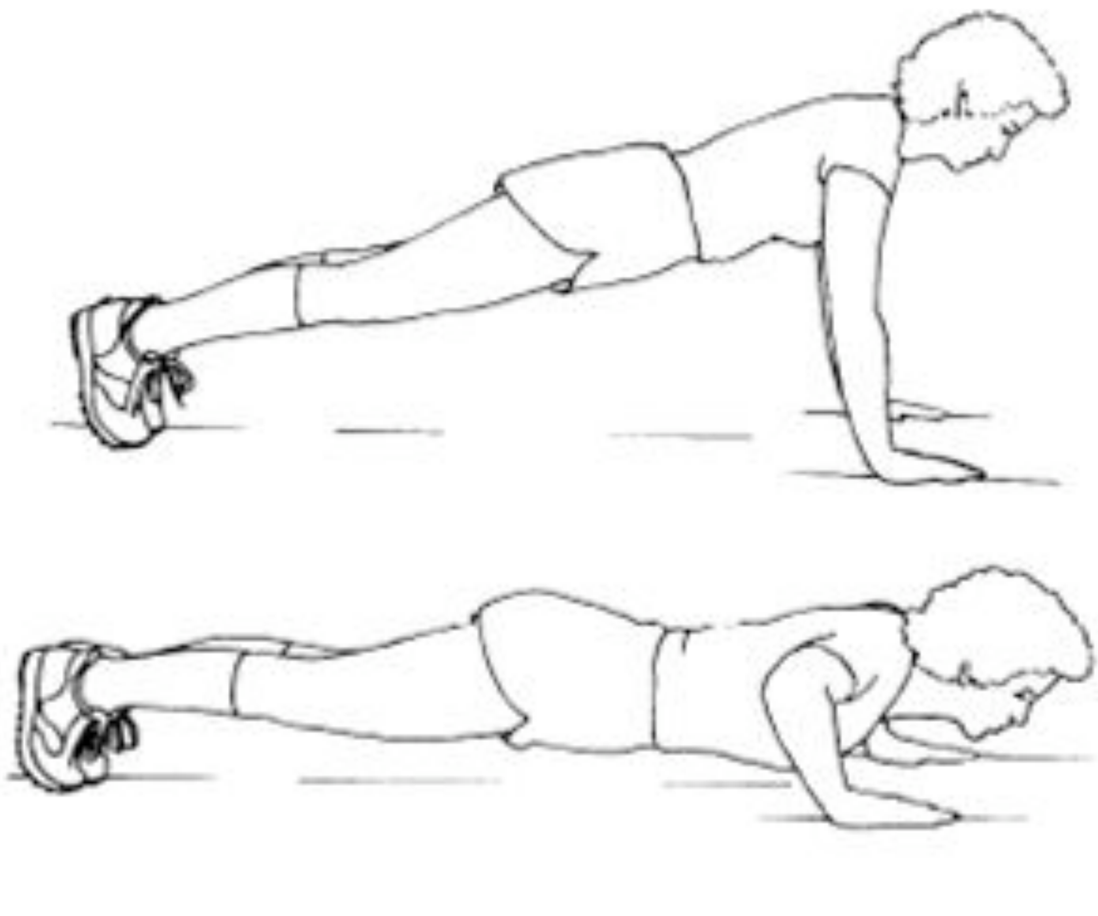
Growing the Food (Run in Place) →

Fuel to transport Food to Processor (Jumping Jacks) →

Processing the Food (Lunges) →

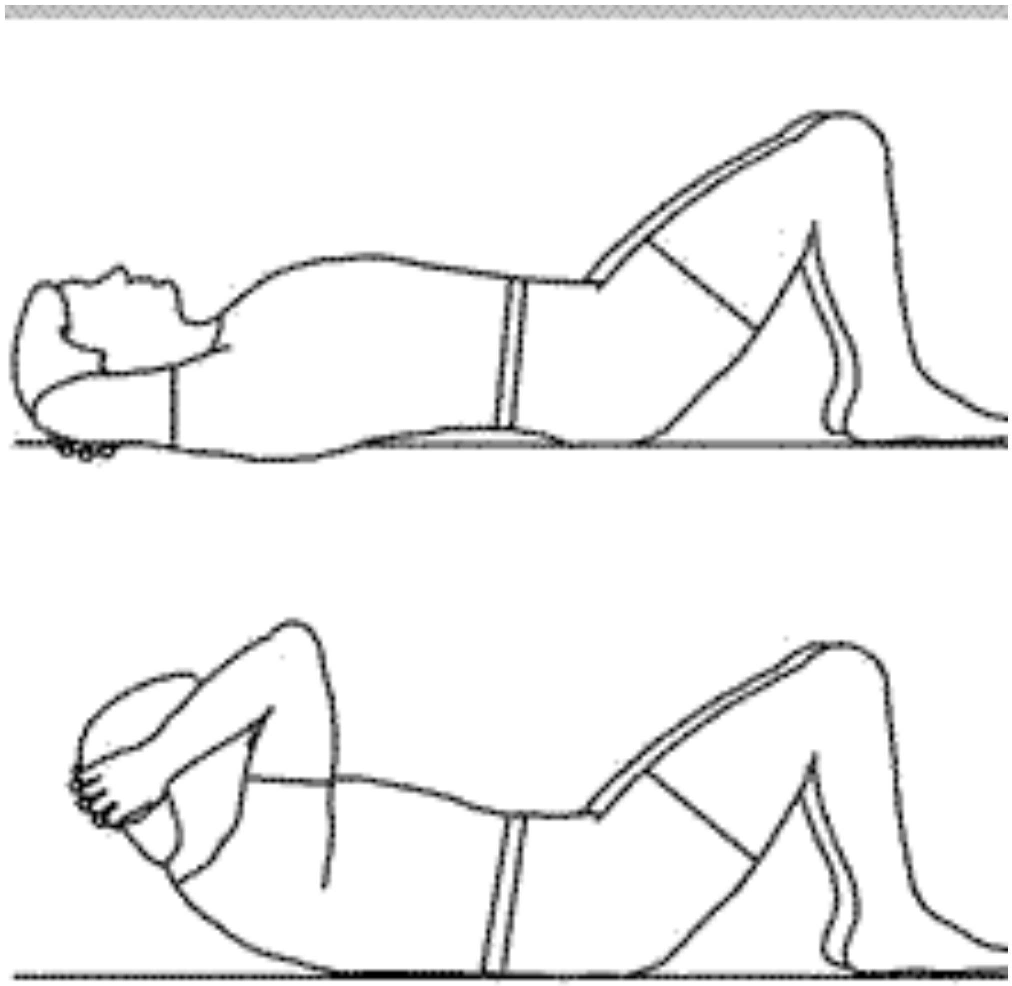


Fuel to Transport Food to Distributor (Push-ups) →

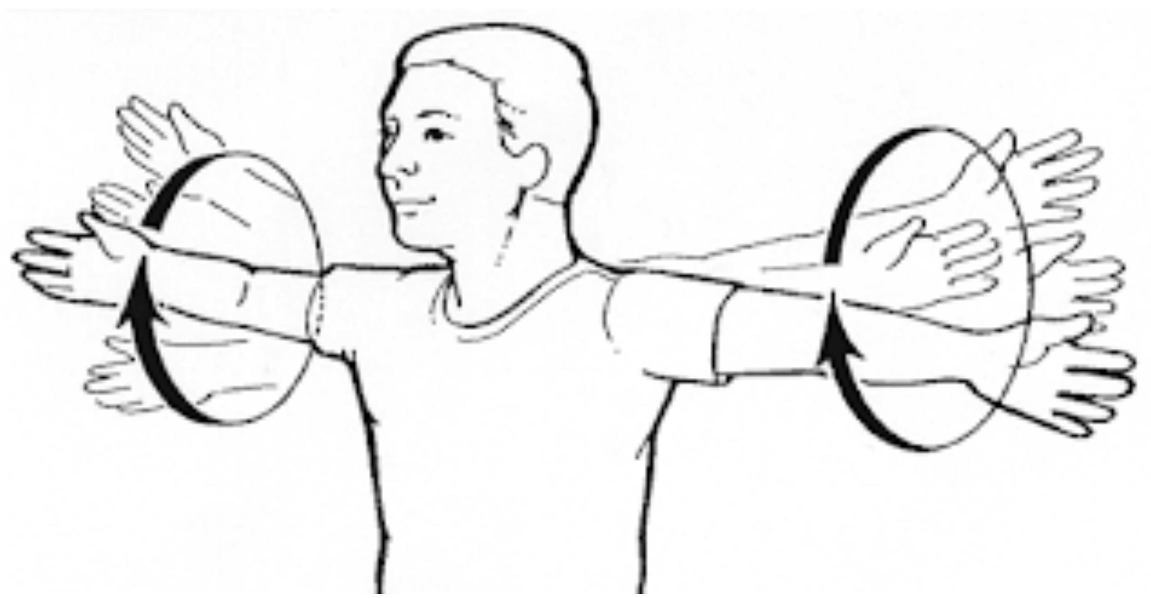


Storing the Food (Squats) →

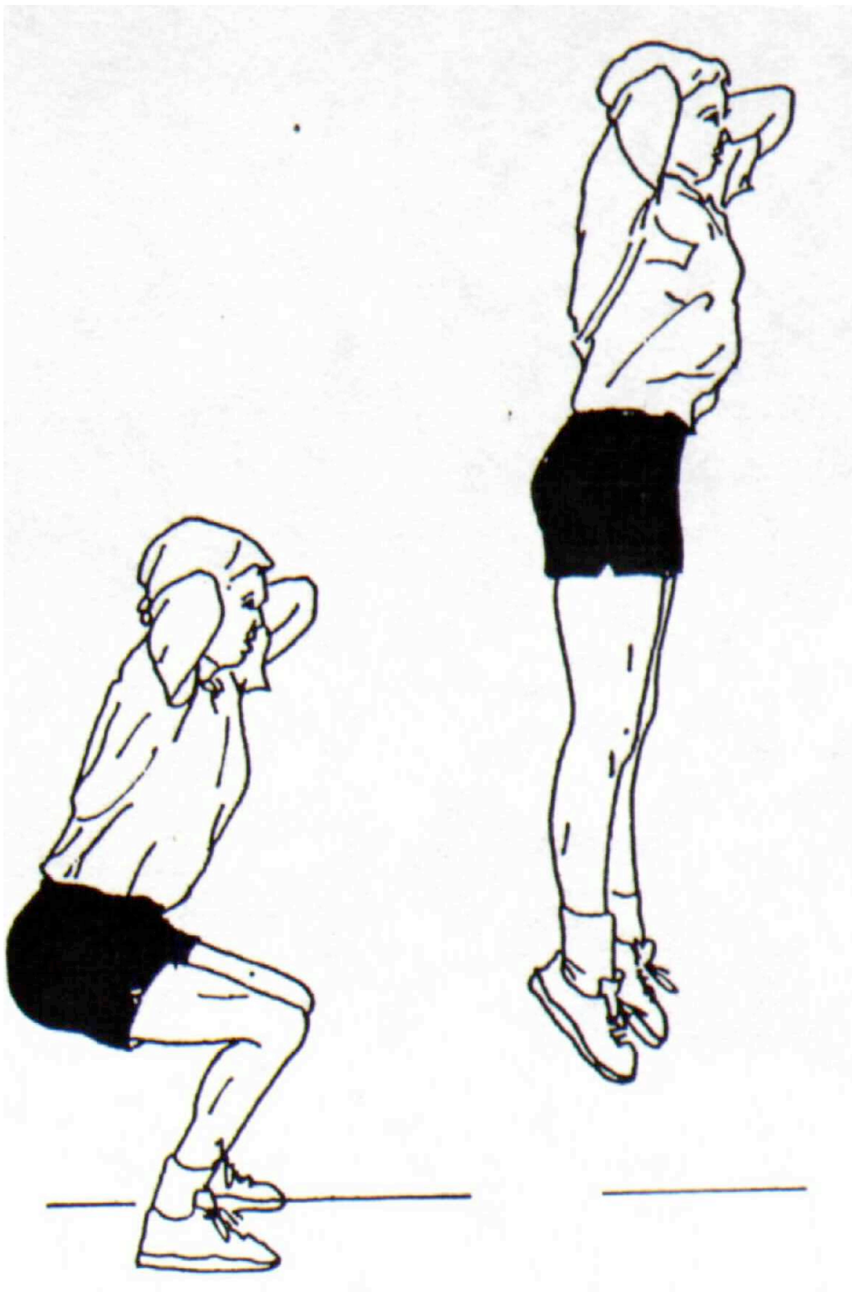
Selling the Food (Crunches) →



Fuel to Transport Food to Home (Arm Circle Exercise) →



Eating the Food (Jump in Place) →



Finish Line!

Plant Sex 101

Plant Sex 101: The importance of pollination and pollinators in every garden

Learn how different plants reproduce, which need help and which are self-sufficient, which attract bees and which rely on the elements, and how plants have evolved over time to attract what they need to reproduce. Also, learn what is happening to our bees and why their demise means our very own.

Outcomes/Objectives:
After this lesson, students will be able to:
- Identify the parts of a flower
- Identify perfect and imperfect flowers on vegetable crops
- Demonstrate the importance of pollinators to crop production
- Identify 5 pollinators common to every garden
- Hand-pollinate 5 garden crops
- Demonstrate knowledge of bees and the role they play in crop production

State Science Standards: Strands 1, 3, and 4, grades K-8

Materials:
- Live male and female squash or pumpkin blossoms or pictures of male and female squash or pumpkin blossoms
- Live perfect flowers or pictures of perfect flowers (tomatoes, eggplant, peppers, etc.)
- Bee-Free BBQ handout
- Parts of the flower handout
- Magnifying glasses (optional)

Follow-up game:
- Socks (one per person)
- Stick-on Velcro or 2-sided tape
- Pom-pom balls (in two colors)

Background information
Pollination is the first step in plant reproduction. Ninety percent of flowering plants depend on animals in order to successfully reproduce. Every third bite of food that we put into our mouths depends on this mutually beneficial relationship between plants and their pollinators.

Flowers can be classified as either monoecious, or imperfect, (meaning that a flower is either male of female) or hermaphroditic, or perfect, (signifying that a single flower has both male and female parts). Examples of both flourish in any garden. Imperfect flowers rely on pollinators to transfer male pollen from one flower to the female pollen of another. This is typically done by insects but can also be achieved by hand as in the case of a school garden. Perfect flowers rely on insects and wind to transfer pollen from the male parts of the flower (the stamen) to the female parts (the stigma). Students can also assist in this process with a timely shake of the plant (as in the case of tomatoes) or a well-aimed cotton swab dabbing first a male and then a female flower.

A vegetable garden is the perfect place to study the intricate process of pollination, especially in the warmer months. This living lab lends itself to scientific observation and hands-on learning in a way that no other classroom does. In a garden, students have the opportunity to witness the intricate relationship between plants and pollinators, to observe the daily growth of a fruit or vegetable from inception to harvest, as well as to participate in what it means to be a pollinator. The imperfect flowers of the squash, melon, cucumber, and pumpkin families are the perfect vehicle for doing this.

The exception to the rule in a school garden is corn, which relies on the wind to pollinate individual kernels of corn. The number of variables that must align in order to successfully pollinate an ear of corn is simply astounding and one of my favorite lessons to teach in the garden. Here it is in a nutshell:

Reproduction begins when the male flower (or tassel) blooms, releasing 2-5 million grains of pollen per tassel. Between 2 and 5 days later, the female flowers (the silk) emerge from the top of the ear of corn. Each of those silks is attached to a seed which, if pollinated, will grow into a single kernel of corn. Each ear of corn has between 400-600 seeds and 750-1,000 silks. A grain of pollen must land on top of a silk and then find its way down that hollow tube where it then fertilizes the seed, enabling it to grow into a single kernel of corn. In order to have a full, juicy ear of corn, between 400 and 600 seeds must be individually pollinated in this way. When a silk has successfully been pollinated, it turns brown and dies. Because corn is wind pollinated, it is usually planted in blocks rather than rows to increase the chance of pollination from any direction. An ear of corn is rarely pollinated by its own male flowers but rather by male pollen being carried across a corn field by gusts of wind. Now think of that next time you see corn on the cob for sale for 10/$1.00!

Studying and demonstrating pollination is also a perfect time to introduce the critical role that bees play in agriculture. Researchers believe that if we lost all of our bees today, we would all starve to death in 4 years. This is s a stunning statistic and one that affects each and every one of us on a very basic level. Honeybees, especially in the Western U.S. have gotten a bad rap in the media since the introduction of “Killer” Africanized bees in 2002. Our very survival depends on these complex creatures and yet we eliminate them at every turn. Bee numbers have been consistently on the decline in recent years due to the phenomenon that scientists have termed “colony collapse disorder” (first observed in 2006). After much research, the main culprit remains to be seen, although fungicides and the neonicitinoids in certain pesticides have been determined to be detrimental to colony health.

Although much can be done on a legislative level to protect our bees, the first step is to raise awareness in our children and citizens about our reliance on bees and encourage, through education, a shift in attitude towards them. Bees do not need us but we most certainly need them!

Plants have evolved through natural selection to attract the pollinator that they need in order to ensure the continuation of their species. Color patterns, shapes, scents, size, and structure all contribute to luring the animals—both invertebrates and vertebrates—to a plant’s reproductive zone, or flower, to pollinate it, thus ensuring the plant’s survival. In his book, <u>The Botany of Desire</u>, Michael Pollan makes a case for how 4 different plant species have evolved to attract humans and ensure their survival through cultivation, care, demand, and in one case, addiction.

Activity 1: Identifying the parts of the flower and hand pollination (optional)

Show students pictures of perfect and imperfect flowers. Help them identify the male and female reproductive parts of the different flowers. Show how, in the case of the squash or pumpkin flower, the female flower always has a miniature squash or pumpkin attached to its base. If you have live flowers, pick one or two male flowers. Have the students gently peel the petals back (the petals are a delicacy, by the way, so for an added treat you can invite the students to taste them!). Have the students identify one or more female flowers on the plant. Pass the male flowers around and have each student transfer some of the male pollen onto the pollen on the female flower. Mark the female flower and observe it over the next few days. If the tiny squash has plumped out and grown, they were successful pollinators; if it is shriveled and dried, they will have to try again on another flower. *This activity is best done in the morning as squash flowers open in the early hours of the day and tend to wilt by noon.

Follow-up Activities:
Student Worksheet 1: Naming the parts of the flower

Student Worksheet 2: Bee-Free Barbecue

Follow-up game: Pollination Station
Divide students into 3 groups. Explain that one group represents female flowers, one group represents male flowers, and that the third group are bees. Give each flower a sock to put on their hand. Attach yellow pollen "balls" to the female flower socks and orange balls to the male flower socks. Have the flowers crouch down and hold their flower socks in the air. The job of the bees is to transfer the male pollen to the female pollen as well as to return to the hive with sufficient pollen to make bee bread for their larvae. The game is finished when the male flowers have no pollen balls, the female pollen balls are orange and/or a mix of yellow and orange, and the bees have sufficient pollen balls of any color to bring back to the hive. Have the students switch roles and try it again.

Additional Resources:

http://www.pollinators.info/wp-content/uploads/2012/02/pollen.pdf Smithsonian in the classroom for lots of pollination ideas, activities, and worksheets

http://www.arcs.co.uk/fun2learn/PDFs/4_POLLINATION_Worksheets.pdf
http://www.business-services.upenn.edu/arboretum/pdf/seedformation.pdf
http://www.pollinator.org/nappc/PDFs/curriculum.pdf
http://edibleschoolyard.org/resource/bees-garden
http://agweb.okstate.edu/fourh/aitc/lessons/upper/pollinat.pdf
http://www.myschoolhouse.com/courses/O/1/124.asp
http://ofrf.org/education/database
http://plantsinmotion.bio.indiana.edu/plantmotion/starthere.html watch the pumpkin cam and see how pumpkins grow at night!